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ABSTRACT

The sampling designs and procedures used by the National Assessment of Educational Progress in its second year assessment activities are documented. The report is organized in three parts. Project objectives and other background information are discussed in the first section. The details of the second year school and household samples are discussed in the second and third parts, respectively. Parts 2 and 3 each contain a general description, discussions of each stage of the design, selected response data, and a discussion of the estimation procedures. (Author/EH)

THE NATIONAL ASSESSMENT APPROACH TO SAMPLING

A Monograph by
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CHAPTER

FOREWORD

One of the strengths of the National Assessment project has been its commitment to a scientific sampling approach. This monograph was written to provide interested persons with a detailed description of the National Assessment sample design for year 02.

Minor changes were made in the basic design for years 03 and 04. This foreword is being used to describe these design changes for those readers who are interested in the year specific design.

Primary sampling units (PSU's) for the years 03 and 04 school samples were selected using controlled selection procedures as described in chapter 10. In year 04, the selection procedure was modified so that all pairs of PSUs had positive joint inclusion probabilities. Clustering of the sample schools within PSUs, described in chapter 5, was discontinued beginning in year 03. Schools which had been selected for the National Assessment school samples in either of the two previous years generally were not selected again for the year 03 and 04 samples.

Size of community (SOC) stratum definitions were revised for year 04 to more nearly equalize the size measures for primary strata. The estimated PSU size measures were based on the 1970 Census Populations for Counties published by the U.S. Bureau of the Census. Socioeconomic status (SES) variables, at the PSU level, were based on 1970 census variables and, at the school level, were based on the proportion of the 1966 tax returns with adjusted gross income of less than $3,000 as tabulated by the Internal Revenue Service for zip code areas. Beginning in year 03, schools with 10 or fewer eligibles were selected with equal probabilities rather than with probabilities proportional to the sizes of schools since all eligibles within schools this small were usually assessed. The procedure that was used to include schools with grade range changes in the proper age-group samples was improved for year 04.

The National Assessment household samples for years 03 and 04 were composed of 104 PSU's, the 52 used in year 02 plus an additional 52 of the 208 sample PSU's selected in year 02 (chapter 10). The planned sample size was 2,000 responses per adult package in each year.

Within sample PSU's, 1970 Census First Count summary tape data were used to stratify enumeration districts (EDs) and block groups (BGs) in years 03 and 04, rather than stratifying census tracts (CTs) and minor civil divisions (MCDs) as in years 01 and 02. An SES index was calculated for each BG and ED based on median housing

value, median rent, and the percentage of housing units with incomplete plumbing facilities. Housing units (HUs) selected for the year 02 sample were not reselected for year 03. Similarly, HUs selected for the year 02 and 03 samples were not reselected for the year 04 sample. The survey weights for each of the young adult packages were adjusted to agree with the census proportions for four regional sex-by-race groups.

Donald T. Searls

PREFACE

This monograph is intended to document the sampling designs and procedures used by the National Assessment of Educational Progress (NAEP) in the year 02 assessment. A much briefer description of the year 01 sample design appears in appendix C to NAEP *Report 1. 1969-1970 Science: National Results and Illustrations of Group Comparisons.*

This monograph is organized in three parts. The project objectives and other background information are discussed in part one (chapters 1-3). The details of the year 02 school and household samples are discussed in parts two (chapters 4-8) and three (chapters 9-13), respectively. Parts two and three each contain a general description discussions of each stage of the design, selected response data, and a discussion of the estimation procedures.

The authors are grateful to the National Assessment of Educational Progress and to the Research Triangle Institute for the opportunity to work on the sampling aspects of the project. Of the many statistic[illegible] who have given us personal inspiration, support, and criticism, [illegible] must single out A. L. Finkner, D. G. Horvitz, and D. T. Searls. We also wish to thank Kay M. Rollins and Hu Burnett for their editorial and technical assistance.

We hope this document will be useful to those who are interested in the National Assessment sampling methodology.

R. Paul Moore
James R. Chromy
W. Todd Rogers

CHAPTER 1

OVERVIEW

The National Assessment of Educational Progress (NAEP) is basically a systematic, census-like survey of understandings, skills, knowledge, and attitudes of young Americans at four age levels. The assessment is designed to gather information about the levels of mastery achieved by populations of 9-year-olds, 13-year-olds, 17-year-olds, and young adults aged 26-35 in each of 10 subject areas commonly included in local school curriculums. The ultimate goal is to provide information to both the education community and the lay public that can be used to improve the educational process.

For a more complete discussion of overall goals, objectives, and programs, the reader is referred to one of the several sources listed at the end of this chapter.[1-3] New terminology used in this monograph is explained in the text and in the glossary.

In the early planning stages, NAEP planners recognized the importance of using probability samples. The application of modern probability sampling[4-7] is essential to allow valid statements to be made about entire populations based on sample data and to allow the precision of such statements to be evaluated based on sampling errors computed from the data.

The first assessment, referred to as year 01, was conducted during 1969. In-school samples were used for 9-, 13-, and 17-year-olds enrolled in school and a household sample was used for young adults (aged 26 to 35) and 17-year-olds not enrolled in school.[8] The sample design was modified so that all states were represented in the in-school sample for year 02. This monograph documents all aspects of the sample design with particular emphasis given to the design for year 02. Further adaptations in sample design are almost certain to occur, but most aspects of the year 02 design will remain in the model to be used for future assessments.

WORKS CITED IN CHAPTER 1

1. Frank B. Womer. *What is National Assessment?* Ann Arbor, Mich.: National Assessment of Educational Progress, 1970.
2. Jack C. Merwin and Frank B. Womer. "Evaluation in Assessing the Progress of Education to Provide Bases of Public Understanding and Public Policy." *NSSE Yearbook: Educational Evaluation: New Roles, New Means.* Chicago: University of Chicago Press, 1969.
3. Ralph W. Tyler. "National Assessment: Some Valuable By-products for Schools." *The National Elementary Principal*, XLVIII, 6, May 1969.

4. Eleanor L. Norris "National Assessment: An Information Gathering and Information Dissemination Project," *Education*, Vol 91, No. 4, April-May 1971, pp. 286-290
5. *Compact*, 6, No. 1 (A complete issue devoted to National Assessment of Educational Progress) February 1972
6. W. G. Cochran, *Sampling Techniques* 2nd ed. New York John Wiley and Sons, Inc., 1963
7. M. H. Hansen, W. N. Hurwitz, and W. G. Madow. *Sample Survey Methods and Theory* 2 vols New York: John Wiley and Sons, Inc., 1953.
8. Leslie Kish. *Survey Sampling*. New York: John Wiley and Sons, Inc., 1965.
9. J. R. Chromy and D. G. Horvitz. "Appendix C: Structure of Sampling and Weighting," *Report 1, 1969-1970 Science National Results and Illustrations of Group Comparisons* Washington, D.C.: Government Printing Office, 1970.

CHAPTER 2

DEVELOPMENT OF SAMPLING PLANS

Introduction

National Assessment is viewed by sampling statisticians as a sample survey. As such, its planning had many features similar to those of other sample surveys: overall objectives had to be defined to maintain consistency in all aspects of the survey design; the population(s) to be observed or measured had to be defined; a method for selecting and measuring members from this population had to be designed; decisions had to be made about what data to collect, how to collect, organize, summarize, and analyze the data, and how to organize the field work. The necessary degree of precision for the principal estimates had to be considered. The total cost of the survey had to be planned within reasonable bounds.

Relating Survey Objectives to Sample Design

No single feature of a survey may be developed independently of the other features. The sample design, in particular, is closely related to all other features of the survey. The sample design is the method of selecting the members of the population which are to be measured. The selected members are the sample. The method of selecting a sample can greatly influence the cost of locating and measuring the members. In practice, these interdependencies may be explored by planning several alternative survey designs and then ruling some of the alternatives unfeasible because of excessive cost or because they do not adhere to the overall survey objectives. The feasible methods may be compared on the basis of cost efficiency, expected precision of estimates, control of bias in the measurement and estimation processes, or general practicability. Pilot studies at this stage of the planning may resolve the more difficult problems.

The general details of sample survey planning discussed above apply to the planning of National Assessment. Details and results of the planning as they relate to the sample design are discussed in this chapter.

Review of Survey Objectives

A few of the objectives of the National Assessment are listed here because they directly affect the entire survey plan and, in particular, the sample design.

1. Long-range emphasis is to be on assessment of progress in education.
2. Results should be understandable to the general public.
3. Results should be used to describe the performance of broad population groups on specific exercises within well-defined educational objective areas.
4. New and different methods of collecting data are to be tried.
5. No individual participant should be required to give more than one hour of his time.
6. The privacy of respondents should be protected to the fullest extent possible.

For a thorough discussion of the general objectives of National Assessment, the reader is referred to other sources.[1-5]

In terms of the general survey design, the first objective required that the study be repeated so that changes over time may be evaluated. The first complete cycle of National Assessment must describe the present status of the outcomes of the educational process and establish a level or "benchmark" for future comparisons.

The second objective most directly affected the development of the specific exercises used in National Assessment and the reporting of results. The third required that the results be reported by individual exercise. The plan for summarizing collected data was to look at specific exercises and to summarize the responses for certain population groups. No test scores for individual participants were to be computed. The objective of reporting results by population groups was a constraint on the sample design since all groups had to be represented in the sample.

The fourth objective most seriously affected the cost structure of the field data collection operation. This objective led to many individually administered exercises, which affected the choice of an efficient sample design.

The fifth objective meant that each participant could not respond to all exercises used for his age group since this would require several hours. This objective necessitated grouping exercises into packages which could be conveniently administered in one hour. This objective meant that the sample design should insure a representative probability sample for each package.

The sixth objective influenced the sample, the data collection, and the data-handling aspects of the survey. In the school sample, all sampling of individual students was done at the school, and names of participants were not removed from the school. In the household sample and other supplementary samples, the names were kept on separate forms and did not appear in connection with the data collected from a respondent.

Defining Target Populations

At an early stage of National Assessment planning, four age groups were selected as the target populations: 9-year-olds, 13-year-olds, 17-year-olds, and young adults 26 to 35 years of age. Definition of the target populations by age, rather than by year or grade in school, is one feature of National Assessment that distinguishes it from most other educational surveys and offers a particular challenge in sample selection and the organization of field procedures.

The target population in each age group was limited to persons residing within the 50 states and the District of Columbia. The exclusions of certain persons who lived in institutions or who were handicapped are discussed in more detail later in relation to the operational aspects of sample selection.

Initial plans were to categorize the population within each age group into subpopulations based on region of the country, community characteristics, sex, and socioeconomic status. The four regions are Northeast, Southeast, Central, and West. The states in each region are shown below.

NORTHEAST REGION	SOUTHEAST REGION
Connecticut	Alabama
Delaware	Arkansas
District of Columbia	Florida
Maine	Georgia
Maryland	Kentucky
Massachusetts	Louisiana
New Hampshire	Mississippi
New Jersey	North Carolina
New York	South Carolina
Pennsylvania	Tennessee
Rhode Island	Virginia
Vermont	West Virginia

CENTRAL REGION	WEST REGION
Illinois	Alaska
Indiana	Arizona
Iowa	California
Kansas	Colorado
Michigan	Hawaii
Minnesota	Idaho
Missouri	Montana
Nebraska	Nevada
North Dakota	New Mexico
Ohio	Oklahoma
South Dakota	Oregon
Wisconsin	Texas
	Utah
	Washington
	Wyoming

Four sizes of communities were considered in the planning stages: large cities (above 180,000 population), urban fringes (communities adjacent to large cities), middle size cities (25,000 to 180,000), and rural (below 25,000).

Subpopulations based on socioeconomic status variables (e.g., income, education, ethnic, or racial background) were difficult to define in such a way that the subpopulation definitions would be both meaningful and operationally feasible to apply. Certain guidelines were established in the design of the sample:

1. Principal interest was in comparing the low end of the socioeconomic scale (e.g., the low-income population) with the remainder of the population.
2. To have an adequate sample to describe the low end of the socioeconomic scale, the sample design should attempt to identify the low socioeconomic subpopulation and should sample it at a higher rate than the remainder of the population.

Cycling the Subject Areas

Initially, 10 subject areas were included in the long-range plans for National Assessment. These areas are Art, Career and Occupational Development, Citizenship, Literature, Mathematics, Music, Reading, Science, Social Studies, and Writing. (Other areas under consideration may be added in the future.) Within each area, educational objectives were developed and then specific exercises were developed to focus on each objective.

Due to the large number of subject areas, objectives within areas, and exercises within objectives, it became apparent that a complete survey covering all 10 subject areas in one year would be an extremely large project. Furthermore, the team assembled to accomplish this task would have to be disbanded after the first survey and reorganized several years later to obtain data for making comparisons. Such a plan, although feasible, had serious drawbacks. A continuous operation cycling plan involving two or three subject areas each year was used instead. The basic plan (Table 2-1) has been revised to put each subject area on a five-year cycle. However, modifications to the basic cycle are possible as needs for assessment data change.

Table 2-1. Planned Five-Year Cycles for National Assessment Subject Areas

Year number	Subject area
01 (1969-70)	Writing, Science, Citizenship
02 (1970-71)	Reading, Literature
03 (1971-72)	Music, Social Studies
04 (1972-73)	Mathematics, Science
05 (1973-74)	Writing, Career and Occupational Development
06 (1974-75)	Art, Citizenship
07 (1975-76)	Reading, Literature
08 (1976-77)	Music, Social Studies
09 (1977-78)	Mathematics, Science
10 (1978-79)	Writing, Career and Occupational Development

Packaging the Exercises

One of the primary objectives of National Assessment was to try new methods of collecting data on educational outcomes. These methods were not to be limited by convenience factors such as ease of administration and scoring of exercises. Each exercise was to be designed for a specific objective within a subject area; for example, a respondent should not be hampered on a Science exercise by his inability to read. As a result of this requirement, the exercises have many unique features. One immediate consequence of the many unique features was the need for specially trained personnel to supervise and administer the exercises and the need for centrally trained supervisors to maintain uniformity of administration methods in all parts of the country.

Most exercises are read to the respondents; others require interviewer-respondent interaction and specially trained interviewers.

A standard taped voice is used for group sessions in schools. Some exercises (e.g., Science area) can be administered only with special equipment to closely supervised individuals. In year 01, some of the Citizenship exercises required two or three specially trained administrators to observe discussion groups. Other exercises (e.g., Music area in year 03) required the recording of responses on magnetic tape. As new subject areas are introduced in the cycling plan, other special features may emerge.

A second primary objective of National Assessment that influenced the methods of data collection was the limitation of individual participation to one hour or less, but no respondent had to attempt all the exercises. Nine-year-olds, 13-year-olds, and 17-year-olds assessed in schools completed one package each. For each age group each year, the exercises were sorted into sets and assembled as 10 or more packages with each package typically containing a variety of exercises from all subject areas assessed that year. For efficient administration in schools, most of the exercises which could be administered to several persons at once were packaged as group-administered packages. Those which required individual administration were called individually administered packages. The numbers of packages by age group and by administration type for year 02 are illustrated in Table 2-2.

In the household sample, all packages were administered individually. Adults and out-of-school 17-year-olds were asked to complete one, two, three, or four assessment packages and were offered a monetary incentive to compensate them for requiring more than one hour of their time and to obtain a high cooperation rate.

Table 2-2. National Assessment Packages Administered to Age Groups, Year 02

Sampled age group	Number of group-administered packages	Number of individually administered packages
School sample		
9-year-olds	9	3
13-year-olds	13	2
17-year-olds	10	2
Household sample		
17-year-olds	--	12
young adults	--	6

The Need for Probability Sampling

Planning revealed that the objectives of National Assessment might be met by a complete enumeration survey or by a sample survey of the target population. The cost of complete enumeration would be unreasonably high. Since the four target age groups are well mixed with the general population, the effort required for a complete enumeration would be comparable to that required for a decennial census of the total population.

Probability sampling allows researchers to collect data from a small portion of the population and to infer certain characteristics of the entire population. That is, certain population averages, totals, or ratios may be estimated using data collected from a sample. Furthermore, if the sampling error of the estimate can be estimated from the data, statements may be made about the precision of the estimates. Sampling error shows how estimates computed from the sample may differ from the corresponding population values which would be obtained from a complete enumeration survey using identical data collection procedures. Nonsampling errors (e.g., errors due to nonresponse, recording, processing) are not reflected in the sampling error; these errors can occur even in a complete enumeration survey.

Because a sample survey involves a smaller workload, more attention can be given to personnel supervision and training, which may, in fact, reduce the nonsampling error. Generally, factors such as cost limitation and control of nonsampling error favor a sample survey over a complete enumeration survey. Other advantages are the opportunity to collect data over a short period of time and the opportunity to use more specialized techniques because of the smaller field force being trained and supervised.

Nonprobability methods for sampling of volunteers or "typical units" chosen by expert judgment are sometimes adequate for certain research projects, but they do not allow valid inferences to be made about the total population. Because of the National Assessment's emphasis on describing entire populations and specified subpopulations, no serious consideration was given to nonprobability sampling methods.

Sample Size

Early in the planning stages, guidelines were needed for sample size—the number of respondents required for each exercise. These guidelines were based on a reasonable level of precision for key estimates that would be consistent with long-range objectives for assessment of progress over time. The sample size should allow

sufficiently precise estimates to detect positive changes in the performance of a subpopulation on specific exercises.

Initial guidelines were based on a simple random sampling scheme. When other sampling schemes are used, the sample size required to achieve the same precision is generally greater by a factor called the design effect.[6,7] Table 2-3 shows the sample sizes required to decide correctly whether a specified change has occurred over time or if no improvement occurred. (Computations in this table assume simple random sampling or a design effect of one.) The sample sizes are computed so that decision of change or no change can be made correctly 9 out of 10 times on the average. (A more detailed illustration of required sample sizes under varying conditions appears in appendix B.) Based on a graphical interpolation of data in Table 2-3, a subpopulation effective sample size of 400 would be adequate to decide correctly in 9 out of 10 cases whether or not positive changes of the following types have occurred:

A change from 0.10 to 0.16,
A change from 0.50 to 0.59, or
A change from 0.90 to 0.91.

Table 2-3. Number of Responses Needed Per Exercise Package to Detect Given Changes in P-Values 9 Out of 10 Times

Change in P-value* from survey 1 to survey 2	Estimated number of responses needed for each survey**
0.10 to 0.15	571
0.10 to 0.20	164
0.10 to 0.25	81
0.10 to 0.30	50
0.50 to 0.55	1,311
0.50 to 0.60	325
0.50 to 0.65	142
0.50 to 0.70	78
0.90 to 0.925	1,660
0.90 to 0.95	355

* P-value is the estimated proportion of eligibles who would answer the exercise correctly.

** The table values are for simple random samples of students; a design effect of one.

Since some of the target subpopulations (e.g., region and community characteristics) partition the population into at least four groups, 1,600 (400 x 4) would be an effective sample size on a national basis to detect real positive changes of the type shown above. If the design effect were larger than one, a somewhat larger sample size would be required. Computations such as these led National Assessment planners to consider sample sizes of 2,000 to 2,500 respondents adequate for each exercise. If 10 packages were used for each age group, the total number of package responses would be approximately 20,000 (2,000 x 10); for the four age groups, the total number for one year would be approximately 80,000 (20,000 x 4).

The actual number of responses differed from this hypothetical example because the numbers of packages varied by age group and because the sample design was adapted to the type of exercises contained in each package. Actual figures on planned sample sizes for year 02 are given in parts 2 and 3 as the sample designs are discussed.

Sampling Frames

To construct a probability sample, planners initially need a list of sampling units, referred to as a sampling frame or a frame. Ultimately, they select from the list a group of associated observational units. If it is possible to list all observational units, the sampling units are the observational units; but in most surveys of human populations, it is not feasible to list all. It is much easier to list school buildings than to list all the students attending classes at these buildings. It is much simpler to list all household addresses or locations in a county than to list all household members in the county. If units such as school buildings or households are used as alternatives to listing all observational units, it is necessary to have an association rule which identifies each observational unit with certain (preferably one) sampling units. For example, a 9-year-old may be associated with the school where he regularly attends classes, and most persons can be associated with a household, depending on the designation of what constitutes membership in a household. However, a few persons may be excluded from both frames because they neither go to school nor belong to a household.

Other economies in listing may be achieved by associating schools or households with identifiable land areas called area segments. The area segments may be cities, counties, or smaller areas. If primary sampling units (PSU's) such as cities or counties are

selected first, frames for the next stage of sampling are needed only within the selected PSU's. At the final stage of sampling, observational units for the target populations are listed for very small proportions of the total population. For National Assessment, the observational units are the persons in each age group who are eligible.

In the planning stages of National Assessment, several choices of sampling frames were considered: (1) a school frame, (2) a household frame, (3) a mixed household and school frame, and (4) frames based on other existing surveys.

A school frame cannot be used to identify the young adult (ages 26 to 35) target population. Since most states have laws requiring school enrollment up to some minimum age, most 9-year-olds and 13-year-olds would be enrolled, but a lower proportion of 17-year-olds would be enrolled. Census estimates for the 1965 noninstitutional population enrolled at the beginning of the school year (October) show 99.3% for persons 7 to 9 years of age, 99.1% for 10 to 13 years of age, and 93.2% for 14 to 17 years of age.[5] Estimates of percentages of enrollees 16-1/2 to 17-1/2 years of age vary with the time of the year. For planning purposes, it was assumed that 75 to 80% of 17-year-olds are enrolled.

A household frame can be used to identify persons in all four age groups. To identify eligible respondents, a roster of occupants by age must be obtained for each household in the sample. This process is called household screening. Based on 1960 population estimates by age group and assuming a total sample of each age group of 20,000 persons, it would be necessary to screen eight of every 10,000 households to obtain an adequate number of young adults. To obtain the same number of 9-year-olds, it would be necessary to screen 50 of every 10,000 households. A high proportion of the field survey costs associated with a household survey of this type are screening costs. The 9-, 13-, and 17-year-olds could be identified at much less cost using a school frame. Other economies, such as group administration of certain packages in schools, would further reduce costs. However, loss of a large portion of the sample due to lack of cooperation from state or district school administration officials was recognized as a disadvantage; thus, the National Assessment survey plans included efforts to obtain the cooperation of these officials whenever possible.

The final choices of sampling frames for National Assessment were a school frame for 9-year-olds, 13-year-olds, and 17-year-olds enrolled in school and a household frame for young adults. No efforts were planned to locate the small number of 9- and 13-year-olds not enrolled. Seventeen-year-olds not enrolled were to be identified with the young adults, but the number of households

screened was to be limited to the number required for the young adult sample. The definition of out-of-school 17-year-olds was expanded to include all persons 16-1/2 to 18-1/2 years old who were not enrolled when they were 16-1/2 to 17-1/2 years old; this definition, which assumed that individual performance on a set of exercises would not change over a year after leaving school, was expected to double the number of out-of-school 17-year-olds identified in the household frame. However, since the total number of out-of-school 17-year-olds in the household sample would still be much smaller than required, other methods of identifying those persons were considered. The use of other national surveys, such as the Current Population Survey (CPS) conducted by the Bureau of the Census, as a screening device required special procedures to obtain permission from individuals in the sample to release their names to an outside survey organization. Due to the anticipated poor results using these procedures, the CPS survey was not used.

In year 01, no supplemental sampling frames for out-of-school 17-year-olds were used. As a result, about 500 individuals were contacted. In year 02, several alternative sampling frames for out-of-school 17-year-olds were developed and tested; this work is discussed more fully in a separate report.[7]

Requirements of the Sample Design

As a result of the planning process for National Assessment, a set of requirements was established for the survey design and the sample design.

1. A probability sample of the general population is required for each of four age groups: 9-year-olds, 13-year-olds, 17-year-olds, and young adults 26-35 years of age.
2. Subpopulations defined by sex, region, community characteristics, and socioeconomic status are to be represented in the samples.
3. The low socioeconomic subpopulation is to be sampled at a higher rate than the remainder of the population.
4. The respondents in each age group participating in a particular exercise package are to be a probability subsample of the overall sample of respondents for that age group.
5. The partitioning of the sample into subsamples for each package must allow group administration of certain packages and individual administration of others.
6. A school sampling frame is to be used for 9-year-olds, 13-year-olds, and 17-year-olds enrolled in school.

7. A household sampling frame is to be used for young adults and 17-year-olds not enrolled in school.
8. Alternative sampling frames used for identifying and assessing out-of-school 17-year-olds more efficiently are to be studied.

The sampling plans discussed in this chapter were used as guidelines in the development of the year 02 designs for the school sample and the household sample, discussed in parts 2 and 3 of this monograph.

WORKS CITED IN CHAPTER 2

1. Frank B. Womer. *What is National Assessment*. Ann Arbor, Mich.: National Assessment of Educational Progress, 1970.
2. Jack C. Merwin and Frank B. Womer. "Evaluation in Assessing the Progress of Education to Provide Bases of Public Understanding and Public Policy," *NSSE Yearbook: Educational Evaluation, New Roles, New Means*. Chicago: University of Chicago Press, 1969.
3. Ralph W. Tyler. "National Assessment: Some Valuable By-products for Schools," *The National Elementary Principal*, XLVIII, 6, May 1969.
4. Eleanor L. Norris. "National Assessment: An Information Gathering and Information Dissemination Project," *Education*, Vol. 91, No. 4, April-May 1971.
5. *Compact*, Vol. 6, No. 1 (A complete issue devoted to National Assessment of Educational Progress), February 1972.
6. Leslie Kish. *Survey Sampling*. New York: John Wiley and Sons, Inc., 1965.
7. J. R. Chromy, R. P. Moore, and A. Clemmer. *Design Effects in the National Assessment of Educational Progress Surveys*. Proceedings of the Social Statistics Section, American Statistical Association, 1972.
8. U.S. Bureau of the Census. *Pocket Data Book, USA, 1969*. Washington, D.C.: U.S. Government Printing Office, 1969.
9. R. Paul Moore and Bruce L. Jones. "Study of Alternative Sampling Frames for Out-of-School 17-Year-Olds," *25U-688-1 Technical Report No. 1*. Research Triangle Park, N.C.: Research Triangle Institute, 1971.

CHAPTER 3

GENERAL DESCRIPTION, SCHOOL SAMPLE

Introduction

This chapter and the next five chapters describe the year 02 school sample design. Chapter 3 gives a general description without going into the details of the sample design; chapter 4 discusses the selection of the primary sampling units (PSUs); chapter 5, the selection of schools within the PSU's. The selection of students and the assignment of specific packages to the students are discussed in chapter 6. The response rates for states, school districts, schools, and individual students are summarized in chapter 7. The basic method used to estimate National Assessment p-values (proportion answering an exercise correctly) is discussed in chapter 8.

Target Populations

The school sample is aimed at three of the four National Assessment age groups: 9-year-olds, 13-year-olds, and 17-year-olds. No other means of sampling is used for 9-year-olds or 13-year-olds; the use of other frames to sample 17-year-olds who are not enrolled in school is discussed in a separate report.[1]

The field operation for year 02 was scheduled so that each age group was assessed during a period of approximately two months. The 13-year-olds were assessed during October and November, followed by 9-year-olds during January and February, and 17-year-olds in March and April.

The birth date eligibility requirements for students in sample schools were based on calendar years for 9- and 13-year-olds and on a special year-long range not coinciding with a calendar year for 17-year-olds. Table 3-1 shows the survey schedule and the eligible birth dates. Table 3-2, calculated from data in Table 3-1, shows the

Table 3-1. Definitions of Target Populations for the School Sample, Year 02

Age group	Survey period	Eligible birth dates
9-year-olds	1-4-71 to 2-26-71	Calendar year 1961
13-year-olds	10-12-70 to 12-11-70	Calendar year 1957
17-year-olds	3-8-71 to 4-30-71	10-1-53 to 9-30-54

age ranges that could occur from application of eligibility criteria: the mid-range age of 9-year-olds was 9 years, 7 months; the mid-range age of 13-year-olds was 13 years, 4-1/2 months, and the mid-range age of 17-year-olds was 17 years.

Table 3-2. Range of Ages for Eligibles in School Sample, Year 02

Age group	Eligible age range		
	Minimum	Mid-range	Maximum
9-year-olds	9 yrs.	9 yrs. 7 mos.	10 yrs. 2 mos.
13-year-olds	12 yrs. 9-1/2 mos.	13 yrs. 4-1/2 mos.	13 yrs. 11-1/2 mos.
17-year-olds	16 yrs. 5-1/2 mos.	17 yrs.	17 yrs. 7 mos.

The Multi-Stage Sample Design

One term used to describe National Assessment sampling is multi-stage, meaning that the sample was selected in stages. (Advantages of multi-stage designs, with respect to sampling frame development, were pointed out in chapter 2.) Multi-stage designs concentrate or cluster the sample and thus reduce field costs.

Constructing Sampling Frames

Four stages of sampling may be identified in the year 02 school sample design (see Figure 3-1). The principle of selecting sampling units with probabilities proportional to their sizes or their estimated sizes was used. The primary sampling units (first-stage units) were geographic land areas consisting of one or more whole counties. The 116 PSU's selected had probabilities approximately proportional to estimated sizes. The size measure was the estimated number of 17-year-olds in each PSU. The same PSU's were used for all three target age group samples.

Secondary sampling units (second-stage units) were formed within a PSU by grouping several postal zip code areas. This type of unit was used only in the highly populated PSU's. It was hoped that the school clustering obtained by forming secondary sampling units within large PSU's would simplify field procedures and ease the inconveniences to the local school systems by reducing the number of administrative units involved. As a means of insuring that some relatively high and some relatively low socioeconomic (SES) areas would be included in the sample, the secondary sampling units in most PSU's were stratified by SES. Two secondary sampling units, one high SES and one low SES, were selected from each PSU. Procedures did not guarantee that the same secondary sampling units would be selected for all three age groups.

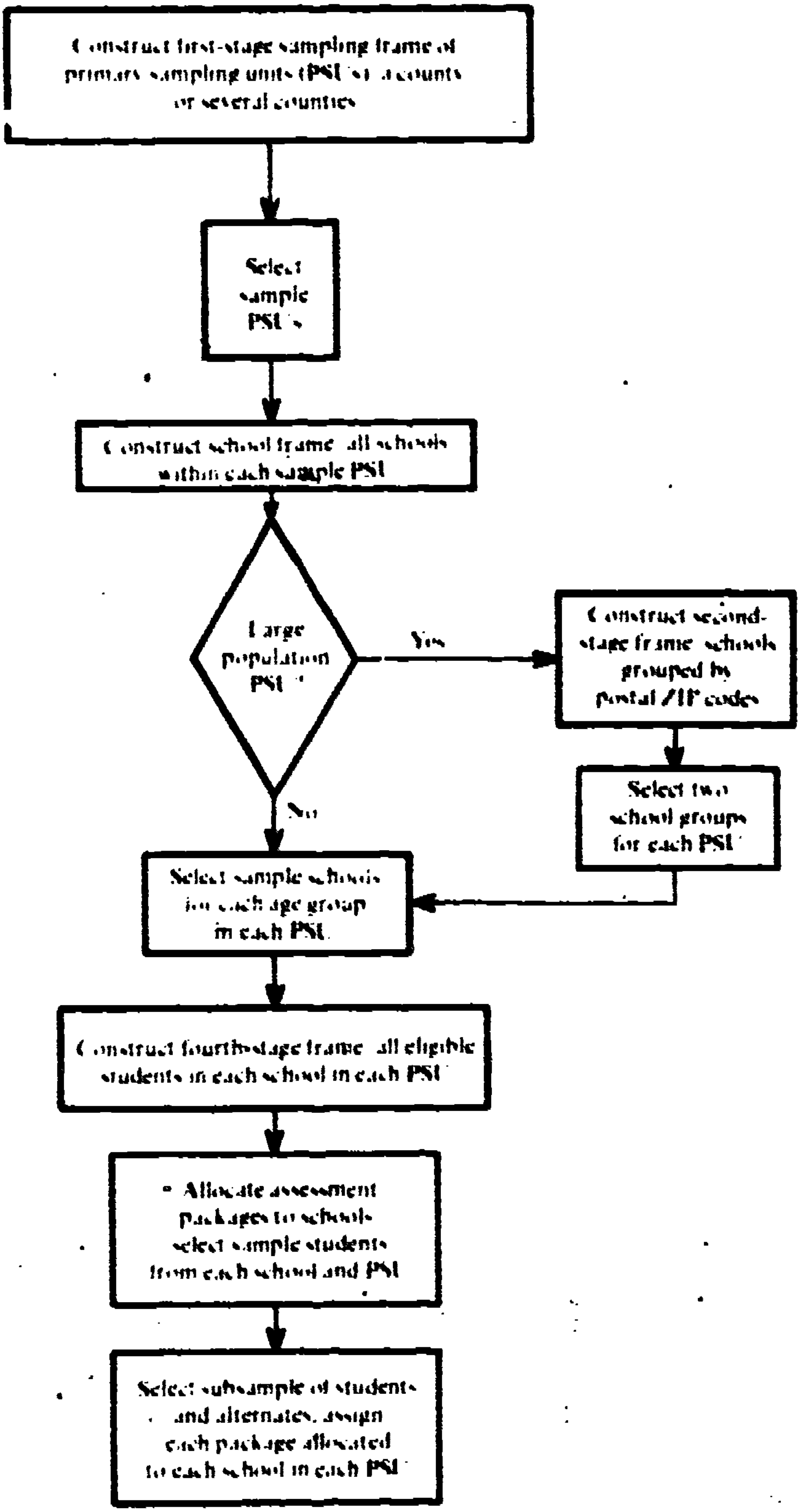

Figure 3-1. Multi-stage sampling design for the school sample

The third-stage sampling units were schools. For each age group, a probability sample of schools was selected from the schools in the secondary sampling unit for that age group. The number of schools selected was determined by the approximate number of eligible students in the age group attending each school; in other words, if the schools had very low enrollments, more schools were required to obtain the prescribed number of students. At least two schools were selected from each second-stage unit so that no single school would be required to supply a large proportion of the respondents within the PSU. This guideline is discussed more fully in chapter 5.

The fourth-stage sampling units were the students at each school who were eligible by birth dates. Special procedures were developed for selecting sample students and for assigning packages either to groups of 12 students or to individuals. These procedures insured that the students assigned to complete any particular package were a probability subsample of all the students selected for the assessment.

Allocating the Sample to States

A special design requirement added in year 02 insured that all states would be included in the sample for each age. If at least one PSU is selected from each state and if an equal number of students are assessed in each PSU, the states with low total populations are allocated a much larger proportion of the total sample than they would be if the allocation were in proportion to state populations. Proportional allocation generally produces estimates for the total population with higher precision. This requirement does not in any way imply that the sample in each state should be adequate for reliable state estimates.

Two types of PSU's were defined to meet this special requirement and, at the same time, to keep the allocation of the sample students to states more nearly in proportion to state populations. Two-week PSU's with a constant student sample size were used in most states; a specially trained National Assessment district supervisor scheduled a two-week visit for each age group and, with two or three locally employed exercise administrators, completed the selection of the sample students and administered all individual and group packages at the sample schools. One-week PSU's used in the small population states were handled in a similar manner but were completed in half the time for half as many students of each age group.

Planned Sample Size

A total sample size of 2,160 was planned for each individually administered package (see chapter 2). The precision of estimates for

group-administered exercises was expected to be lower because of a higher design effect; therefore, a sample size of 2,592 was planned. Table 3-3 summarizes total sample sizes planned by age group, by package, and by package type. The total for 9-year-olds was 29,808; for 13-year-olds, 38,016; for 17-year-olds, 30,240; and for all three age groups, 98,064.

Table 3-3. Sample Sizes Planned for Age Groups, Year 02

Type of package administered	Number of packages	Overall Sample: Sample size package	Overall Sample: Total sample size	Two-week PSU *: Sample size package	Two-week PSU *: Total sample size	One-week PSU *: Sample size package	One-week PSU *: Total sample size
Individually to:							
9-year-olds	3	2,160	6,480	20	60	10	30
13-year-olds	2	2,160	4,320	20	40	10	20
17-year-olds	2	2,160	4,320	20	40	10	20
Group sessions:							
9-year-olds	9	2,592	23,328	24	216	12	108
13-year-olds	13	2,592	33,696	24	312	12	156
17-year-olds	10	2,592	25,920	24	240	12	120

* Primary sampling unit.

For each two-week PSU, sample sizes were 20 for each individually administered package and 24 for each package administered to two group sessions of 12 students each. This general plan by age and type of package is illustrated in Table 3-3. The total planned sample in a two-week PSU was 276 for 9-year-olds, 352 for 13-year-olds, 280 for 17-year-olds, and 908 for the three age groups.

In each one-week PSU, sample sizes of 10 for each individually administered package and 12 for each group-administered package were planned (see Table 3-3). The total planned sample size for all age groups was 454, exactly one-half the planned sample size for each two-week PSU.

The primary sample stratification and selection procedures are discussed in detail in chapter 4, which follows.

WORKS CITED IN CHAPTER 3

1. R. P. Moore and B. L. Jones. 25U-688-1 *Technical Report No. 1 Study of Alternative Sampling Frames for Out-of-School 17-Year-Olds.* Research Triangle Park, N.C., Research Triangle Institute, 1971.

CHAPTER 4

THE SCHOOL PRIMARY SAMPLE FOR YEAR 02

Introduction

Guidelines for the year 02 school design (chapter 2) required that probability samples of subpopulations (9-year-olds, 13-year-olds, and 17-year-olds) enrolled in school be representative of regional, community size, and socioeconomic status characteristics. An additional requirement was the inclusion of at least one primary sampling unit (PSU) from each of the 50 states and the District of Columbia.

Meeting all sampling requirements simultaneously necessitated special stratification and selection procedures. A method of deep stratification called controlled selection permitted the selection of a probability sample from a two-dimensional grid in a way that satisfied restrictions placed on marginal sample totals. Use of controlled selection satisfied the original objectives specified for National Assessment stratification by first allocating the sample to major strata based on region, community characteristics, and socioeconomic factors. Then, the requirement of allocating at least one PSU to each state could be considered separately as the second dimension within each region. In practice, some adjustment of the first allocation to major strata occurred due to rounding-off of the sample allocated to each state and due to the use of special one-week PSUs (see chapter 3). Details of these stratification and allocation procedures are discussed in the next section. The order of discussion does not follow exactly the steps taken in practice since the two tasks are so closely interrelated.

The chronological order for constructing and stratifying the primary sampling frame was as follows:

1. List the counties or similar units, the required population totals, and the estimated size measures (number of 17-year-olds).
2. Sort the list by regional strata.
3. Sort the counties by size of community (SOC) within each region.
4. Combine the counties, as needed, to form PSUs containing minimum populations.
5. Recalculate size measures and calculate socioeconomic status (SES) indices by PSUs.
6. Identify self-representing PSUs.
7. Define SES substrata within SOC 3 and SOC 4 and sort PSUs

by SES within SOC strata.

8. Sort PSU's by states within major strata.

The final allocation of the sample PSU's to strata and the selection of the probability sample of PSU's are discussed in the last two sections of this chapter.

Constructing the Primary Sampling Frame

By definition, the first stage sampling frame from which the primary sample was selected is a list of PSUs. Each PSU for the school sample consisted of one or more counties. Every county in the United States was included in exactly one PSU in the overall list. Special areas, not politically defined as counties, were also included and treated as counties; examples of such areas are election districts in Alaska, parishes in Louisiana, and independent cities in certain states.

Changes in the county structure of states occur periodically even though counties are relatively stable, well-defined units. For the year 02 sample, county lists and area definitions were based on data from the 1960 Census of Population and Housing (the 1967 County and City Data Book). Data collection was scheduled for the 1970-71 school year, but current local area population counts or estimates were not available; that is, 1960 Census data were the most recent data that included single year-of-age tabulations by counties. The 1966 estimates were available for total county populations.

Procedures for combining counties into multiple-county units to form PSUs were based on consideration of (1) the stratification criteria, (2) the need to have a sufficiently large population in each PSU for the within-PSU sample, (3) the need for oversampling the low SES population within SOC 1 and 2 PSU's, and (4) the need for combining counties to obtain PSU areas for practical field operations.

Combining two or more counties to form some PSUs was necessary to have a sufficiently large population (at least 50,000) to allow for selection of 276 9-year-olds; 352 13-year-olds, and 280 17-year-olds from students enrolled in school (see Table 3-3) and to allow for error and variation in age distribution. Since the low SES population was to be oversampled within PSU's classified as SOC 1 or SOC 2, a larger pool of eligible respondents was required. An arbitrary minimum PSU size of 100,000 total population was used in SOCs 1 and 2 to permit low SES oversampling at subsequent stages of sampling. The total number of PSU's in the sampling frame after combining counties to meet the minimum population requirements was 1,180; this may be contrasted with a total of 3,128 counties or

similar units used as the building blocks for constructing PSUs.

Although many PSUs were single counties or similar units, most PSUs were multiple-county types, particularly in SOCs 3 and 4. Stratification criteria affected the choices of counties that could be combined to form a PSU. It was considered desirable to combine contiguous counties that were in the same stratum that is, the same major SOC stratum and state stratum. When it was not possible to meet both the "contiguity" and the "same stratum" criteria, contiguous counties within the same state but in different SOC strata were combined, and the entire PSU was classified by the lowest SOC number of any of its counties. For example, if a SOC 2 county was combined with a SOC 1 county, the entire PSU was classified as a SOC 1. Stratification by SES was done without difficulty after counties were combined as PSUs.

In addition to defining each PSU in the sampling frame in terms of counties, it was necessary to derive two measures for each PSU. The first was the estimated PSU size needed for determining selection probabilities or expected sample sizes, and the second was an SES index to be used for stratification of SOC 3 and 4 PSUs. Conventionally, the size measure used in sample designs is the number or the estimated number of persons in the target population within each PSU; but for random drawing of three age group samples, the selection probability had to be fixed at a single value for each PSU. The choices of a single size measure included total population, number of 13-year-olds, number of 17-year-olds, and certain broader age groups. Experience had shown that the age distribution of the population, which varies considerably among counties, could cause difficulties for the within-PSU sampling. The final and somewhat arbitrary choice—an attempt to recognize both population change factors and age distribution factors—was to estimate the number of 17-year-olds in each county. First, the 1970 total population was estimated for each county (equation 4.1) by linear projection of 1960 Census population counts and published 1966 Census county population data:

$$P_{ij}^{70} = P_{ij}^{60} + 10\left(\frac{P_{ij}^{66} - P_{ij}^{60}}{6}\right) , \qquad (4.1)$$

where

P_{ij}^{70} = linear projection of 1970 county population of the j-th county in the i-th region;

P_{ij}^{60} = 1960 Census count of the total county population; and

P_{ij}^{66} = 1966 Census estimate of the total county population.

Next, the number of 17-year-olds in each county was estimated using equation 4.2 to relate the differences in age distribution to regions in which the PSU was located and to the percentage of urban population in the PSU:

$$S_{ij} = \left(a_i R_{ij} + b_i U_{ij} \right) P_{ij}^{70} . \tag{4.2}$$

where

S_{ij} = estimated size measure (number of 17-year-olds) for the j-th county of i-th region;

R_{ij} = proportion of the county population classified as rural in the 1960 Census; and

U_{ij} = proportion of the county population classified as urban in the 1960 Census.

The parameters a_i and b_i were estimated by applying statistical regression procedures to 1960 Census data for a sample of counties. These estimates are shown in Table 4-1. The estimates of numbers of 17-year-olds were somewhat crude since no attempt was made to project percentage urban from 1960 to 1970, but the result was an improvement over other available data since the purpose of the overall projection technique was to get a realistic *relative* size measure (S_{ij}) for each county.

Table 4-1. Parameters Used in Developing PSU Size Measures

Region	Index (i)	a_i	b_i
Northeast	1	.01738	.01533
Southeast	2	.02076	.01496
Central	3	.01820	.01432
West	4	.01898	.01527

An example of a sampling frame listing for a major stratum by state stratum cell is shown in Table 4-2. This table shows a single county PSU and two multiple-county PSUs within stratum number 4613; this number denotes region 4 (West), stratum 6 (SOC 3 high SES), and state 13 (Idaho).

Table 4-2. Sampling Frame Within Stratum 4613*

PSU number	County code	County name	Population 1960	Population 1966	Population 1970**	Percent low SES	Percent urban	Estimated 17-year-olds
1	1	Ada	93,460	99,200	103,027	16.2	70.2	1,687.1
2	3	Bannock	49,342	49,800	50,105	14.0	79.4	803.4
	15	Caribou	5,976	7,300	8,183	17.9	0.0	155.3
	4	Bear Lake	7,148	6,400	5,901	17.0	44.0	102.4
	21	Franklin	8,457	8,000	7,695	27.1	43.0	133.8
	36	Oneida	3,603	3,100	2,765	26.6	0.0	52.5
	39	Power	4,111	4,900	5,426	18.0	0.0	103.0
	16	Cassia	16,121	18,000	19,253	20.1	46.6	332.1
		Total	94,758	97,500	99,328	17.3	55.0	1,682.5
3	10	Bonneville	46,906	51,700	54,896	13.0	70.7	897.9
	33	Madison	9,417	10,200	10,722	20.5	50.6	183.4
	41	Teton	2,639	3,100	3,407	27.0	0.0	64.7
	22	Fremont	8,679	9,400	9,881	24.2	31.1	176.1
		Total	67,641	74,400	78,906	16.0	60.0	1,322.1

* West region, 4; major stratum, 6; state, 13.

** Projected.

Allocation to Regional Strata

The four regional strata defined for sampling purposes corresponded exactly to regional subpopulations—Northeast, Southeast, Central, and West—defined in chapter 2. Figure 4-1 shows the regional strata on an outline map of the United States. Since regions are one of the major reporting categories in National Assessment, a decision was reached to allocate the total sample of 108 two-week PSUs equally to the regions; that is, 27 two-week PSUs would be allocated to each region. Table 4-3 shows the sample allocation, the population totals, and the estimated measures of size (number of 17-year-olds) of the regions.

For optimum allocation to estimate national values, one would assume equal within-region variances and allocate the sample in direct proportion to the size of the regional target populations. Equal rather than proportional allocation was chosen to provide maximum

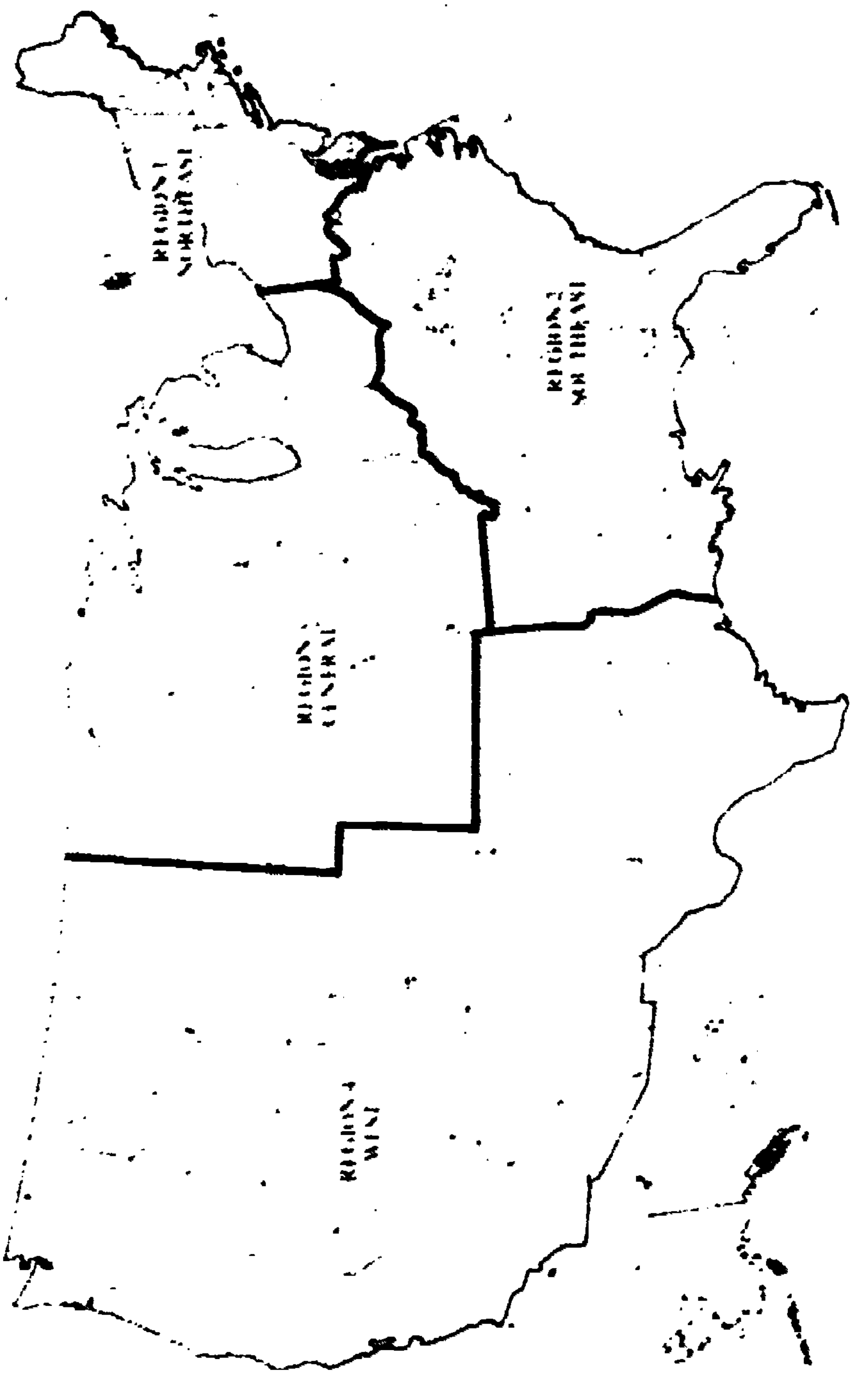

Figure 4-1. National Assessment Regional Strata.

Table 4-3. Allocation of Two-Week PSUs to Regional Strata

Regional stratum	Population distribution: 1960 Census population	Population distribution: Percent of total population	Size measure distribution: Estimated 17-year-olds*	Size measure distribution: Percent of total size measure	Number of two-week PSUs allocated
Northeast	48,988,756	27.32	869,293	25.95	27
Southeast	38,754,215	21.61	798,933	23.85	27
Central	51,619,139	28.79	879,433	26.25	27
West	39,961,065	22.28	802,045	23.95	27
Total	179,323,175	100.00	3,349,704	100.00	108

* Number of 17-year-olds in PSUs projected from the 1960 Census, the 1966 county populations, and the adjusted urban-rural population distributions.

efficiency for regional comparisons and to obtain approximately equal precision for regional estimates. It was estimated that the variances of national estimates would be increased by a factor of about 2%.

Stratification Within Regions

Size of Community (SOC) Strata

Within each regional stratum, the first level of stratification was related to size of community (SOC). Four SOC strata were defined and used to classify entire counties since the PSUs were to be either single counties or multiple-county units.

The four classification rules, given below, rely heavily on Standard Metropolitan Statistical Areas (SMSAs), which are special statistical tabulation areas defined by the Bureau of the Census for studying metropolitan problems.

- SOC 1 Includes all counties containing a central city with a population of 180,000 or more.
- SOC 2 Includes all counties in the same SMSA as a SOC 1 county.
- SOC 3 Includes all counties not included in SOC 1 or SOC 2 that are either a part of an SMSA or that contain at least one city with a 1960 population of 25,000 or more.
- SOC 4 Includes all counties not included in SOC 1, 2, or 3.

SOC 1, basically the large-city stratum, also contains other areas in the county; all counties in SOC 1 are part of some SMSA. Typically, the SMSA contains (1) at least one central city of 50,000 or more

population; (2) the county containing this city; and (3) in many cases, one or more adjacent metropolitan counties near the large central city. SOC 2 contains counties of this type—that is, those adjacent to the county containing the large central city. SOC 3 is composed of counties containing cities of 25,000 to 180,000 population plus adjacent counties belonging to the same SMSAs as these cities. The remaining counties, those with no city as large as 25,000 and which did not belong to an SMSA, were included in SOC 4.

One problem arose in the New England states, where SMSAs are defined by towns which are smaller than counties. These official definitions could cause parts of the same county to be included in different SMSAs or one part within an SMSA and another part outside an SMSA. To avoid this problem, if any part of a county was in an SMSA, the entire county was considered an SMSA county.

Within the regions, the probability of selection for each PSU was approximately proportional to the PSU size measure. This probability of selection can more conveniently be considered as an expected sample size in repeated sampling. The preliminary expected sample size for each PSU was computed as 27 times the PSU size measure, divided by the sum of the size measures for all PSUs in the region. Within SOC 1, some PSUs were so large that the expected sample size equaled or exceeded one; these PSUs, classified as self-representing strata, were automatically selected. After the expected sample size was rounded to an integer, the within-PSU sample was set at the equivalent of one, two, or more PSUs. Table 4-4 lists the self-repre-

Table 4-4. Self-representing PSUs and Expected Sample Sizes

Region and PSU	Expected sample size (two-week PSUs)	Final allocation	
		No. of PSUs	Weeks/PSU
Northeast			
District of Columbia	0.445	1	1
New York, N.Y.	3.894	4	2
Philadelphia County, Pa.	0.985	1	2
Central			
Cook County, Ill.	2.670	3	2
Wayne County, Mich.	1.208	1	2
West			
Los Angeles County, Calif.	3.780	4	2

senting strata and shows the initial and final sample allocations to these strata. Philadelphia County, Pennsylvania, was only slightly less than one; and the District of Columbia was classed as self-representing due to the all-state requirement. The Southeast region had none.

Socioeconomic Status (SES) Strata

Sampling a greater proportion of the low than of the high socioeconomic status (SES) population referred to as oversampling to permit reporting of estimates for subpopulations on the lower extreme of the SES scale was established as an objective in the early planning stages of National Assessment. If the general population could be neatly sorted into two groups, low SES and high SES, the technical sampling problem for meeting this objective could be easily resolved. The real situation existing in the U.S. population did not allow for such simple resolution.

The PSU's, which are usually counties, vary considerably in the proportion of the population which can be identified as low SES; but almost every PSU contains some. Most secondary sampling units, local areas within a PSU, contain some persons in each SES category. Within schools, the third-stage sampling units, it would seem possible to identify students as either low SES or high SES; but this process requires gathering information from school records, from teachers, or from the student himself. In year 01, many counselors and teachers would not classify students within schools as low or as high SES on a relative scale based on judgment; in some cases, asking for the school staff to perform this task may have affected the willingness of schools to cooperate in National Assessment.

For the year 02 sample, planners decided to classify the population by SES at one of two stages: at the PSU stage or at the within-PSU stage. The first method was useful for relatively small PSU's in SOC strata 3 and 4. In SOC strata 1 and 2, more data were available, so schools within PSU's could be grouped into high and low SES areas. The PSU's of SOC 1 and 2 were more internally heterogeneous (in terms of SES) than the PSU's of SOC 3 and 4; this factor also influenced the approach used to oversample the low SES population.

The variable selected to identify low SES at the PSU stage was "percentage of the population earning less than $3,000 a year."* Table 1-5 shows the range of this variable within each SOC substratum of each regional stratum. The wide ranges in SOC's 3 and 4 indicated that stratification and disproportionate sampling rates at the PSU stage would include more low SES persons in the sample than proportionate sampling would.

*County data from the 1960 Census

Table 4-5. Variation in SES Index for PSUs, by SOC Stratum

Region and SOC	Number of PSUs in sampling frame	Percent of families earning less than $3,000		
		Minimum	Maximum	Range
Northeast				
SOC 1	14	0.0	22.1	22.1
SOC 2	23	5.5	19.4	13.9
SOC 3	70	5.5	33.3	27.8
SOC 4	67	7.9	35.7	27.8
Southeast				
SOC 1	14	12.5	31.4	18.9
SOC 2	12	5.8	37.6	31.8
SOC 3	102	11.2	60.2	49.0
SOC 4	290	17.6	71.6	54.0
Central				
SOC 1	20	5.9	16.9	11.0
SOC 2	23	7.2	20.9	13.7
SOC 3	101	10.3	32.8	22.5
SOC 4	227	13.3	57.7	44.4
West				
SOC 1	23	10.2	27.8	17.6
SOC 2	13	8.6	40.6	32.0
SOC 3	71	0.2	58.7	58.5
SOC 4	110	10.9	61.8	50.9

In applying disproportionate rather than proportionate sampling rates, some increase in variance of the aggregate estimates—estimates for combined low and high SES subpopulations—was expected. This increase in variance is a function of two factors: (1) the portion of the population oversampled (sampled at a higher than proportionate rate), and (2) the relative rate of oversampling (the ratio of the higher than proportionate sampling rate to the lower than proportionate sampling rate). Table 4-6 shows the effects of these two factors on variances. As shown, the increase in variance (e.g., 1.015) may be minimized by keeping the ratio of sampling rates (1.5:1) low and by oversampling either a very small portion (0.1) or a very large

Table 4-6. Increase in Variance of Aggregate Estimates* Due to Oversampling Low SES Stratum

Proportion of population oversampled	Ratio of sampling rates**			
	1.5:1	2.0:1	2.5:1	3.0:1
.1	1.015	1.045	1.081	1.120
.2	1.027	1.080	1.144	1.213
.3	1.035	1.105	1.189	1.280
.4	1.040	1.120	1.216	1.320
.5	1.042	1.125	1.225	1.333
.6	1.040	1.120	1.216	1.320
.7	1.035	1.105	1.189	1.280
.8	1.027	1.080	1.144	1.213
.9	1.015	1.045	1.081	1.120

* Aggregate estimates for population groups irrespective of SES.
**Sampling rate for oversampled portion divided by sampling rate for remaining portion.

portion (0.9) of the population. The largest variance would occur if the population was divided into two equal groups (0.5 and 0.5) and if one group was sampled at a much higher rate than the other.

Oversampling of the low SES causes the segment of the population included in the remaining SESs to be sampled at a lower rate than they would be with proportionate sampling. Table 4-7 shows how both sampling rates would be affected by varying the portion of the population oversampled at a rate of 1.5:1 or 2.0:1. If the portion oversampled was minimized (0.2 or less), the sampling rate for the low SES could be greatly increased without drastically reducing the sampling rate in the remaining strata. Conversely, if the portion oversampled was high (0.8 or more), the sampling rate for the low SES could be only slightly increased; and the remainder would be sampled at a sharply reduced rate.

The results in Tables 4-6 and 4-7 led to the decision that, at the PSU stage, the low SES oversampled should be limited to 20% of the total population within SOC's 3 and 4 and that the oversampling rate should be 2:1 or less. The exact limits for these two could not be precisely controlled since each stratum consisted of whole counties and the final allocation of sample PSU's to SOC strata had to be integers.

Table 4-7. Ratios of Disproportionate to Proportionate Sampling Rates When Part of the Population Is Oversampled

Proportion of population oversampled	Ratio of sampling rates*			
	1.5:1		2.0:1	
	R_1/R	R_2/R	R_1/R	R_2/R
.1	1.43	.95	1.82	.91
.2	1.36	.91	1.67	.83
.3	1.30	.87	1.54	.77
.4	1.25	.83	1.43	.71
.5	1.20	.80	1.33	.67
.6	1.15	.77	1.25	.62
.7	1.11	.74	1.18	.59
.8	1.07	.71	1.11	.56
.9	1.03	.69	1.05	.53

* R_1/R, R_2/R where R_1 = sampling rate applied to oversampled portion, R_2 = sampling rate applied to remaining portion, and R = average sampling rate, or rate that would apply to total population under proportional allocation.

State Strata

A special all-state requirement (that each state be included in the sample) was placed on the year 02 school sample design. The use of one-week PSU's to maintain a more nearly proportional allocation of the sample to states was discussed in chapter 3.

Disproportionate sampling had to be done, particularly for certain very low-population states, to permit the use of states as strata. The estimated effects on the variances of regional estimates are fairly minor, as shown in Table 4-8. For certain subpopulation estimates, reduced variances cannot be claimed as a result of the disproportionate allocations either because state estimates were not required or because the year 02 sample sizes would not provide even minimally precise estimates for most states.

The use of one-week PSU's in certain small-population states necessitated increasing the primary sample size from 108 two-week PSU's to a total of 116 PSU's (100 two-week and 16 one-week). The total number of weeks of work was held at a constant 216.

Final Allocation of Sample to Within-Region Strata

Within regional strata, the allocation of PSU's to SOC and state strata was to be approximately proportional to the aggregate stratum

Table 4-8. Increase in Variance of Regional Estimates Due to Disproportionate Allocations to States

Region	Number of PSUs		Effect of disproportionate PSU allocation*
	2-week	1-week	
Northeast	24	6	1.04591
Southeast	27	0	1.01891
Central	26	2	1.02531
West	23	8	1.03587
Total	100	16	

* Ratio of variance for regional estimates using the year 02 allocation to states to the variance that would be obtained with proportional allocation of the sample to each state.

size measures. However, some small-population states and portions of SOC's 3 and 4, identified as low SES, had to be sampled at a higher than proportional rate. The initial allocations were proportional to stratum size measures. Subsequently, several small-population states were designated as one-week PSU states, the number of sample PSUs for the region was recalculated, and the allocations to SOC and state strata were adjusted to fixed integer values. To determine the final allocations to cells of the state by major stratum array (the eight major strata listed in Table 4-9), the initial allocations were revised in an iterative manner.

Table 4-9. Major Within-Region Strata

Major stratum number	Within-region definition
1	SOC 1, self-representing PSUs
2	SOC 1, sampled PSUs
3	SOC 2, self-representing PSUs
4	SOC 2, sampled PSUs
5	SOC 3, low SES PSUs
6	SOC 3, high SES PSUs
7	SOC 4, low SES PSUs
8	SOC 4, high SES PSUs

The within-region stratum definitions for eight major strata are shown in Table 4-9. Stratum 1, defined as "SOC 1, self-representing," was present in all regions except the Southeast; strata 2, 4, 5, 6, 7, and 8 occurred in all four regions; stratum 3, defined as "SOC 2, self-representing," was an empty stratum in all regions.

The number of PSU's in the sampling frame are shown in Table 4-10 for each major stratum of the four regions. Tables 4-11, 4-12,

Table 4-10. Number of PSU's in Sampling Frame

Regional stratum	Major stratum* 1	2	4	5	6	7	8	Total
Northeast	3	11	23	23	47	11	56	174
Southeast	--	14	12	28	74	51	239	418
Central	2	18	23	26	75	37	190	371
West	1	22	13	21	50	20	90	217
Total	6	65	71	98	246	119	575	1,180

* Stratum 3 was empty for all regions.

Table 4-11. Estimated 17-Year-Olds for the Northeast Region, 1970

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Conn.	--	--	--	--	47,667	--	1,388	49,055
Del	--	--	--	--	6,073	1,369	1,490	8,932
D C	14,313	--	--	--	--	--	--	14,313
Maine	--	--	--	3,425	3,174	4,109	5,334	16,042
Md.	--	23,590	7,042	4,564	18,671	3,586	5,402	62,855
Mass	--	20,150	41,192	6,684	16,728	--	2,661	87,415
N H	--	--	--	--	7,009	--	4,673	11,682
N J	--	25,137	30,538	5,220	45,146	--	10,223	116,264
N Y.	125,356	49,832	54,112	10,812	30,641	--	22,775	293,528
Pa.	31,718	24,472	42,849	18,518	37,244	6,482	26,446	187,729
R I	--	9,512	--	1,333	2,226	--	1,359	14,430
Vt.	--	--	--	1,488	--	1,056	4,504	7,048
Total	171,387	152,693	175,733	52,044	214,579	16,602	86,255	869,293

*. Stratum 3 was empty

Table 4-12. Estimated 17-Year-Olds for the Southeast Region, 1970

State stratum	Major stratum* 2	4	5	6	7	8	Total
Ala	16,747	--	10,429	10,928	2,031	24,457	64,592
Ark	--	--	9,174	4,874	5,494	18,168	37,710
Fla	41,263	--	--	41,411	--	24,759	107,433
Ga	16,332	6,376	1,206	18,223	3,125	38,312	83,574
Ky	10,887	--	1,009	11,715	8,123	27,452	59,186
La	9,921	7,482	2,186	16,449	3,633	26,319	65,990
Miss	--	--	4,748	7,877	18,732	13,797	45,154
N C	6,752	--	6,798	25,426	7,268	50,349	96,593
S C	--	--	--	25,960	2,673	21,298	49,931
Tenn	11,625	--	4,199	21,582	11,007	23,511	71,924
Va	7,796	25,039	2,015	10,205	--	38,923	83,978
W Va	--	3,901	--	9,173	--	19,794	32,868
Total	121,323	42,798	41,764	203,823	62,086	327,139	798,933

* Strata 1 and 3 were empty

Table 4-13. Estimated 17-Year-Olds for the Central Region, 1970

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Ill	86,954	--	23,453	2,618	24,926	1,057	30,512	169,520
Ind	--	11,404	4,485	7,631	32,668	--	24,989	81,177
Iowa	--	4,077	--	7,200	11,710	3,414	18,012	44,413
Kans	--	8,898	3,319	1,017	4,513	904	18,294	36,945
Mich	39,360	7,796	22,622	1,954	35,800	--	29,125	136,657
Minn	--	19,351	5,534	3,424	5,544	5,798	18,256	57,907
Mo	--	35,793	4,046	7,482	--	17,827	8,630	73,778
Nebr	--	6,806	--	1,118	2,246	2,985	10,157	23,312
N Dak	--	--	--	923	3,378	960	5,559	10,820
Ohio	--	77,351	21,180	3,609	31,532	1,137	31,024	165,833
S Dak	--	--	--	--	2,381	5,495	3,414	11,290
Wis	--	14,895	4,167	2,856	24,306	981	20,576	67,781
Total	126,314	186,371	88,806	39,832	179,004	40,558	218,548	879,433

* Stratum 3 was empty

4-13, and 4-14 show the size measures for each region in a state by major stratum array. An example of the initial proportional allocation for the West is shown in Table 4-15. The cell values in the table were calculated proportionate to the cell size measures shown in Table 4-14.

Table 4-14. Estimated 17-Year-Olds for the West Region, 1970

State stratum	Major stratum*							Total
	1	2	4	5	6	7	8	
Alaska	--	--	--	--	1,788	--	3,318	5,106
Ariz	--	20,511	--	--	--	2,085	6,633	29,229
Calif	112,281	75,718	12,479	2,212	103,601	--	24,018	330,309
Colo	--	7,420	10,771	2,913	5,167	--	7,600	33,871
Hawaii	-	10,244	--	--	2,453	--	--	12,697
Idaho	--	--	--	--	4,692	--	7,633	12,325
Mont	--	--	--	--	5,602	--	6,694	12,296
Nev		--	--	--	6,782	--	1,777	8,559
N Mex	--	4,720	--	2,729	2,968	1,179	5,541	17,137
Okla	--	17,157	--	7,749	1,986	5,048	10,872	42,812
Oreg	--	11,201	2,518	--	6,961	--	14,567	35,247
Texas	--	81,864	7,116	26,613	22,183	19,996	29,887	187,659
Utah	--	7,427	1,614	--	4,292	--	4,157	17,490
Wash	--	20,714	5,889	--	11,781	--	13,663	52,047
Wyo	--	--	--	--	2,864	--	2,397	5,261
Total	112,281	256,976	40,387	42,216	183,120	28,308	138,757	802,045

* Stratum 3 was empty

The next task in allocating the sample among strata was to examine the allocation of two-week PSU's that each state would be expected to receive given the initial allocation. On the basis of the initial allocation entries, the states which were to be allocated a single one-week PSU were identified. In most cases, states designated for one-week PSU's had an expectation of less than one-half of a PSU. For example, in the West, the one-week PSU states were identified from Table 4-15 as Alaska, Hawaii, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming. A total of six states were designated as one-week PSU states in the Northeast, none in the Southeast, and two in the Central. Since two one-week PSUs were considered the equivalent of one two-week PSU for sample allocation purposes, the initial allocations were increased from 27 to 30 PSUs in the

Table 4-15. Initial Primary Sample Allocation for the West Region

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Alaska	--	--	--	--	0.060	--	0.112	0.172
Ariz.	--	0.690	--	--	--	0.070	0.223	0.983
Calif.	3.780	2.549	0.420	0.074	3.488	--	0.809	11.120
Colo.	--	0.250	0.363	0.098	0.174	--	0.256	1.141
Hawaii	--	0.345	--	--	0.083	--	--	0.428
Idaho	--	--	--	--	0.158	--	0.257	0.415
Mont	--	--	--	--	0.189	--	0.225	0.414
Nev.	--	--	--	--	0.228	--	0.060	0.288
N. Mex	--	0.159	--	0.092	0.100	0.040	0.187	0.578
Okla.	--	0.578	--	0.261	0.067	0.170	0.366	1.442
Oreg.	--	0.377	0.085	--	0.234	--	0.490	1.186
Texas	--	2.756	0.240	0.896	0.747	0.673	1.006	6.318
Utah	--	0.250	0.054	--	0.144	--	0.140	0.588
Wash	--	0.697	0.198	--	0.397	--	0.460	1.752
Wyo	--	--	--	--	0.096	--	0.081	0.177
Total	3.780	8.651	1.360	1.421	6.165	0.953	4.672	27.002

* Stratum 3 was empty.

Northeast, from 27 to 28 in the Central, and from 27 to 31 in the West.

Next, the allocations to SOC, SES, and state margins were determined as fixed integer values. Table 4-16 shows the allocation of PSU's to SOC strata. The allocation of the sample PSUs to SOC strata was based on a proportional-to-size-of-stratum rule. The size measure used in making this allocation was the projected number of 17-year-olds. The allocation is shown in terms of the total number of PSU's, which includes both two-week and one-week PSUs. The final allocations to SOC strata within regions are roughly in proportion to the estimated numbers of 17-year-olds (see Table 4-16).

Table 4-17 shows actual allocation of the sample to the two SES strata within SOC strata 3 and 4 of each region. The final allocations to the low SES portion were determined such that the oversampling was effected but the final allocations were generally not allowed to exceed twice the values of the initial proportional allocations. The high SES allocations were determined by subtracting the low SES allocations from the SOC stratum allocations shown in Table 4-16.

Table 4-16. Primary Sample Allocation to SOC Strata

Region and SOC	1970 estimated 17-year-olds	Percent of total	Initial allocation*	Final allocation**	Percent of final allocation
Northeast					
SOC 1	324,080	37.3	10,067	11	36.7
SOC 2	175,733	20.2	5,458	6	20.0
SOC 3	266,623	30.7	8,283	9	30.0
SOC 4	102,857	11.8	3,195	4	13.3
Total	869,293	100.0	27,003	30	100.0
Southeast					
SOC 1	121,323	15.2	4,100	4	14.8
SOC 2	42,798	5.4	1,446	2	7.4
SOC 3	245,587	30.7	8,299	8	29.6
SOC 4	389,225	48.7	13,155	13	48.2
Total	798,933	100.0	27,000	27	100.0
Central					
SOC 1	312,685	35.5	9,600	10	35.7
SOC 2	88,806	10.1	2,727	3	10.7
SOC 3	218,836	24.9	6,718	7	25.0
SOC 4	259,106	29.5	7,955	8	28.6
Total	879,433	100.0	27,000	28	100.0
West					
SOC 1	369,257	46.1	12,431	13	41.9
SOC 2	40,387	5.0	1,360	2	6.5
SOC 3	225,336	28.1	7,586	9	29.0
SOC 4	167,065	20.8	5,625	7	22.6
Total	802,045	100.0	27,002	31	100.0
U.S. total					
SOC 1	1,127,345	33.7	36,198	38	32.8
SOC 2	347,724	10.4	10,991	13	11.2
SOC 3	956,382	28.5	30,886	33	28.4
SOC 4	918,253	27.4	29,930	32	27.6
Total	3,349,704	100.0	108,005	116	100.0

* Two-week PSU's.

** All PSU's (one-week and two-week).

Table 4-17. Allocation to SES Strata, SOC 3 and 4

Stratum	1970 estimated 17-year-olds	Initial allocation*	Final allocation**	Ratio of SES S.R. to average SOC S.R.***
Northeast				
SOC 3, low SES	52,044	1.616	3	1.71
SOC 3, high SES	214,579	6.667	6	0.83
SOC 4, low SES	16,602	0.516	1	1.55
SOC 4, high SES	86,255	2.679	3	0.89
Southeast				
SOC 3, low SES	41,764	1.411	2	1.47
SOC 3, high SES	203,823	6.888	6	0.90
SOC 4, low SES	62,086	2.099	3	1.45
SOC 4, high SES	327,139	11.056	10	0.92
Central				
SOC 3, low SES	39,832	1.222	2	1.57
SOC 3, high SES	179,004	5.496	5	0.87
SOC 4, low SES	40,558	1.245	2	1.60
SOC 4, high SES	218,548	6.710	6	0.89
West				
SOC 3, low SES	42,216	1.421	2	1.19
SOC 3, high SES	183,120	6.165	7	0.96
SOC 4, low SES	28,308	0.953	2	1.69
SOC 4, high SES	138,757	4.672	5	0.86

* Two-week PSUs.

** Allocation in this column is on the basis of total PSUs which include some one-week and some two-week PSUs.

*** These factors are expressed as $R_1 \cdot R$ and $R_2 \cdot R$ in Table 4-7.

Table 4-18. Summary of Design Factors Related to Low SES Oversampling

Region and SOC	Proportion of population in low SES stratum	Rate of oversampling (R_1/R_2)	Estimated effect on variances of aggregate estimates
Northeast			
SOC 3	0.195	2.06	1.086
SOC 4	0.161	1.74	1.043
Southeast			
SOC 3	0.170	1.63	1.034
SOC 4	0.160	1.58	1.029
Central			
SOC 3	0.182	1.80	1.053
SOC 4	0.157	1.80	1.047
West			
SOC 3	0.187	1.24	1.007
SOC 4	0.169	1.97	1.067

Table 4-19. Sample Allocation to State Strata, Year 02

Region and state	Initial allocation (2-wk. PSUs)	Final allocation: No. of PSUs	Final allocation: Wks. per PSU	Region and state	Initial allocation (2-wk. PSUs)	Final allocation: No. of PSUs	Final allocation: Wks. per PSU
Northeast				**Southeast**			
Conn.	1.524	1	2	Ala.	2.219	2	2
Del.	0.278	1	1	Ark.	1.403	1	2
D.C.	0.445	1	1	Fla.	3.337	3	2
Maine	0.499	1	1	Ga.	2.753	3	2
Md.	1.953	2	2	Ky.	1.984	2	2
Mass.	2.716	3	2	La.	2.246	2	2
N.H.	0.363	1	1	Miss.	1.786	2	2
N.J.	3.611	3	2	N.C.	3.187	3	2
N.Y.	9.118	9	2	S.C.	1.544	2	2
Pa.	5.830	6	2	Tenn.	2.470	3	2
R.I.	0.447	1	1	Va.	3.014	3	2
Vt.	0.219	1	1	W.Va.	1.057	1	2
Total	27.003	30		Total	27.000	27	
Central				**West**			
Ill.	5.204	5	2	Alaska	0.172	1	1
Ind.	2.492	2	2	Ariz.	0.983	1	2
Iowa	1.364	1	2	Calif.	11.120	10	2
Kans.	1.135	1	2	Colo.	1.141	1	2
Mich.	4.196	4	2	Hawaii	0.428	1	1
Minn.	1.777	2	2	Idaho	0.415	1	1
Mo.	2.265	3	2	Mont.	0.414	1	1
Nebr.	0.716	1	2	Nev.	0.288	1	1
N.Dak.	0.332	1	1	N.Mex.	0.578	1	1
Ohio	5.091	5	2	Okla.	1.442	2	2
S.Dak.	0.347	1	1	Oreg.	1.186	1	2
Wis.	2.081	2	2	Texas	6.318	6	2
Total	27.000	28		Utah	0.588	1	1
				Wash.	1.752	2	2
				Wyo.	0.177	1	1
				Total	27.002	31	

The last column in Table 4-17 shows the ratios of SES-stratum sampling rates to proportional sampling rates; these ratios varied from 1.19 to 1.71 for the low SES strata and from 0.83 to 0.96 for the high SES strata.

Table 4-18 summarizes the SES-related sample design factors. The proportion of the population oversampled in SOCs 3 and 4 ranged from 0.157 to 0.195. The rate of oversampling, shown in the second column, ranged from 1.24 to 2.06. The estimated effect of disproportionate sampling on the variances of aggregate estimates is shown in the last column. In no case was the increase of variances estimated to be more than 9%.

The final allocations to state strata, shown in Table 4-19, are approximately proportional to the initial allocations to states. Most of the deviations from proportional allocation were due to rounding to integer values.

The initial cell allocations were adjusted in an iterative manner until the cell values shown in Tables 4-20, 4-21, 4-22, and 4-23 were obtained. The cell values are the expected PSU sample sizes in repeated sampling. The expected sample sizes in the body of these

Table 4-20. Final Primary Sample Allocation for the Northeast Region

State stratum	Expected sample sizes by major stratum*							Total PSUs allocated	Weeks per PSU
	1	2	4	5	6	7	8		
Conn.	--	--	--	--	0.960	--	0.040	1	2
Del.	--	--	--	--	0.633	0.200	0.167	1	1
D.C.	1.000	--	--	--	--	--	--	1	1
Maine	--	--	--	0.300	0.146	0.278	0.276	1	1
Md.	--	0.754	0.253	0.233	0.487	0.127	0.146	2	2
Mass.	--	0.672	1.489	0.358	0.418	--	0.063	3	2
N.H.	--	--	--	--	0.599	--	0.401	1	1
N.J.	--	0.703	0.928	0.226	0.959	--	0.184	3	2
N.Y.	4.000	1.403	1.747	0.600	0.756	--	0.494	9	2
Pa.	1.000	0.809	1.583	0.837	0.917	0.225	0.629	6	2
R.I.	--	0.659	--	0.142	0.125	--	0.074	1	1
Vt.	--	--	--	0.304	--	0.170	0.526	1	1
Total	6.000	5.000	6.000	3.000	6.000	1.000	3.000	30	

* Stratum 3 was empty.

Table 4-21. Final Primary Sample Allocation for the Southeast Region

State stratum	Expected sample sizes by major stratum* 2	4	5	6	7	8	Total PSUs allocated	Weeks per PSU
Ala	0.511	--	0.480	0.275	0.082	0.652	2	2
Ark.	--	--	0.336	0.098	0.176	0.390	1	2
Fla	1.258	--	--	1.066	--	0.676	3	2
Ga.	0.603	0.328	0.067	0.573	0.157	1.272	3	2
Ky	0.372	--	0.052	0.342	0.378	0.856	2	2
La.	0.299	0.315	0.100	0.422	0.149	0.715	2	2
Miss.	--	--	0.273	0.255	0.966	0.506	2	2
N.C.	0.273	--	0.296	0.689	0.280	1.462	3	2
S.C.	--	--	--	0.922	0.207	0.871	2	2
Tenn	0.421	--	0.295	0.815	0.605	0.864	3	2
Va	0.263	1.182	0.101	0.291	--	1.163	3	2
W.Va	--	0.175	--	0.252	--	0.573	1	2
Total	4.000	2.000	2.000	6.000	3.000	10.000	27	

* Strata 1 and 3 were empty

Table 4-22. Final Primary Sample Allocation for the Central Region

State stratum	Expected sample sizes by major stratum* 1	2	4	5	6	7	8	Total PSUs allocated	Weeks per PSU
Ill.	3.000	--	0.675	0.106	0.575	0.030	0.614	5	2
Ind	--	0.285	0.132	0.317	0.774	--	0.492	2	2
Iowa	--	0.088	--	0.256	0.237	0.087	0.332	1	2
Kans	--	0.249	0.108	0.047	0.046	0.036	0.514	1	2
Mich	1.000	0.408	0.795	0.096	1.023	--	0.678	4	2
Minn	--	0.640	0.215	0.189	0.174	0.232	0.550	2	2
Mo.	--	1.252	0.167	0.441	--	0.761	0.379	3	2
Nebr.	--	0.285	--	0.078	0.091	0.154	0.392	1	2
N.Dak	--	--	--	0.142	0.301	0.104	0.453	1	1
Ohio	--	2.340	0.759	0.182	0.892	0.044	0.783	5	2
S.Dak	--	--	--	--	0.177	0.518	0.305	1	1
Wis.	--	0.453	0.149	0.146	0.710	0.034	0.508	2	2
Total	4.000	6.000	3.000	2.000	5.000	2.000	6.000	28	

* Stratum 3 was empty

Table 4-23. Final Primary Sample Allocation for the West Region

State stratum	Expected sample sizes by major stratum* 1	2	4	5	6	7	8	Total PSUs allocated	Weeks per PSU
Alaska	--	--	--	--	0.372		0.628	1	1
Ariz	--	0.716	--	--	--	0.150	0.134	1	2
Calif	4.000	2.189	0.567	0.000	2.601	--	0.553	10	2
Colo	--	0.203	0.471	0.096	0.099	--	0.131	1	2
Hawaii	--	0.868	--	--	0.132	--	--	1	1
Idaho	--	--	--	--	0.404	--	0.596	1	1
Mont	--	--	--	--	0.482	--	0.518	1	1
Nev	--	--	--	--	0.806	--	0.194	1	1
N Mex	--	0.268	--	0.228	0.144	0.148	0.212	1	1
Okla	--	0.735	--	0.480	0.070	0.461	0.254	2	2
Oreg	--	0.343	0.122	--	0.185	--	0.350	1	2
Texas		2.400	0.325	1.106	0.530	1.241	0.398	6	2
Utah	--	0.447	0.149	--	0.215	--	0.189	1	1
Wash	--	0.831	0.366	--	0.392	--	0.411	2	2
Wyo	--	--	--	--	0.568	--	0.432	1	1
Total	4.000	9.000	2.000	2.000	7.000	2.000	5.000	31	

* Stratum 3 was empty.

tables add to the integer allocation for states and for major strata within regions. Comparing the values in Table 4-23 with the initial allocation calculated (Table 4-15) shows the allocations for the West are approximately proportional. The effects of oversampling low SES within SOC 3 and SOC 4 and the effects of oversampling a number of small population states are evident.

Selection of the Probability Sample of PSUs

The next step, after constructing the sampling frame and setting the expected sample allocations (Tables 4-20, 4-21, 4-22, and 4-23), was to select the actual sample of PSU's. The selection required two steps: (1) the controlled selection of a sample pattern; and (2) the selection of the sample PSU's, given the selected pattern, with probabilities proportional to size.

Controlled Selection of the Sample Pattern

Execution of the two steps is discussed using the West for

illustration. Table 4-23 shows the expected sample size for the West for each major stratum by state stratum cell. The equivalent of four self-representing PSU's were allocated on a certainty basis to Los Angeles County (Table 4-1). Controlled selection insured that the actual sample allocation to any cell was within one of the expected values shown in Table 4-23. This meant that the minimum allocations shown in Table 4-24 could be assured for cells having expected sample sizes greater than or equal to one. Six cells, each with minimum allocation greater than zero, accounted for 12 PSU's; the other 19 PSU's were allocated to the cells using the probabilities shown in Table 4-25. (Note that the entries in Table 4-25 may be added to the entries in Table 4-24 to obtain those in Table 4-23.)

Table 4-24. Minimum Cell Allocations for the West Region

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Alaska	.	--	--	--	0	--	0	0
Ariz	--	0	--	--	--	0	0	0
Calif	4	2	0	0	2	--	0	8
Colo	--	0	0	0	0	--	0	0
Hawaii	--	0	.	--	0	--	--	0
Idaho	--	--		.	0	--	0	0
Mont	--	--	--	--	0	--	0	0
Nev	--	--	--	--	0	--	0	0
N Mex	--	0	--	0	0	0	0	0
Okla	--	0	--	0	0	0	0	0
Oreg	--	0	0	-	0	--	0	0
Texas	--	2	0	1	0	1	0	4
Utah	--	0	0	--	0	--	0	0
Wash	--	0	0	--	0	--	0	0
Wyo	--	--	--	--	0	--	0	0
Total	4	4	0	1	2	1	0	12

* Stratum 3 was empty

A probability sampling technique called controlled selection was used to allocate the 19 PSU's. This was done by constructing a set of allocations or patterns and assigning probabilities to these patterns to meet two requirements: (1) each pattern must satisfy certain row-total and column-total constraints exactly; and (2) in repeated sampling of the patterns, the overall probability of including any

Table 4-25. Probabilities of Increasing Minimum Cell Allocations by One PSU, West

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Alaska	--	--	--	--	0.372	--	0.628	1
Ariz	--	0.716	--	--	--	0.150	0.134	1
Calif	0.000	0.189	0.567	0.090	0.601	--	0.553	2
Colo	--	0.203	0.471	0.096	0.099	--	0.131	1
Hawaii	--	0.868	--	--	0.132	--	--	1
Idaho	--	--	--	--	0.404	--	0.596	1
Mont	--	--	--	--	0.482	--	0.518	1
Nev	--	--	--	--	0.806	--	0.194	1
N Mex	--	0.268	--	0.228	0.144	0.148	0.212	1
Okla	--	0.735	--	0.480	0.070	0.461	0.254	2
Oreg		0.343	0.122	--	0.185	--	0.350	1
Texas		0.400	0.325	0.106	0.530	0.241	0.298	2
Utah		0.447	0.149	--	0.215	--	0.189	1
Wash	--	0.831	0.366	--	0.392	--	0.411	2
Wyo	--	--	--	--	0.568	--	0.432	1
Total	0.000	5.000	2.000	1.000	5.000	1.000	5.000	19

* Stratum 3 was empty

particular cell must agree with the probabilities shown in Table 4-25. Even though the allocations to cells are done on a probability basis, the row and column totals are controlled for all possible patterns; that is, the number of sample PSU's in each state and in each SOC stratum are held constant for all sample patterns and thus are not subject to sampling variations.

Thirty-three patterns which satisfied the above two constraints were constructed. These patterns are shown in appendix C. The row and column sample totals are the same for each of the 33 patterns. Table 4-26 shows the probability of selection assigned to each pattern. One pattern was selected to determine the allocation of the 19 PSU's to 19 particular cells of Table 4-25. The total sample allocation to cells was determined by adding the selected pattern entries, cell by cell, to the entries of Table 4-24. If a pattern is selected with the stated probability, the probability of allocating another PSU to any particular cell will agree with the value shown in Table 4-25. For instance, the cell identified as "Colorado-Major

Table 4-26. Probabilities Assigned to Controlled Selection Patterns

Pattern number	Pattern probability: Assigned	Pattern probability: Accumulated	Pattern number	Pattern probability: Assigned	Pattern probability: Accumulated
1	.076	.076	17	.016	.587
2	.017	.093	18	.016	.603
3	.039	.132	19	.005	.608
4	.045	.177	20	.017	.625
5	.025	.202	21	.021	.646
6	.032	.234	22	.018	.664
7	.048	.282	23	.048	.712
8	.020	.302	24	.040	.752
9	.058	.360	25	.024	.776
10	.010	.370	26	.067	.843
11	.002	.372	27	.025	.868
12	.116	.488	28	.007	.875
13	.006	.494	29	.024	.899
14	.012	.506	30	.055	.954
15	.012	.518	31	.011	.965
16	.053	.571	32	.010	.975
			33	.025	1.000

stratum 2" appears in allocation pattern numbers 11, 12, 14, 23, and 33. The sum of the probabilities (Table 4-26) of these patterns is 0.203 (.002 + .116 + .012 + .048 + .025), which agrees with the value shown in Table 4-25. The method of generating the patterns is not discussed in this monograph; briefly, it is a numerical search for a single solution from an infinite number of possible solutions.

Within each region, a single pattern was selected by drawing a random number between zero and one from a list of random digits. When this number was compared with the accumulated probabilities (Table 4-26), the first pattern on the list with an accumulated probability equal to or exceeding the random number drawn was the one selected. As a hypothetical example, if the random number 0.6513 were drawn, allocation pattern number 22 would be selected.

Selection of Sample PSU's

Once the sample allocation to stratum cells was completed, as described above, the only step remaining was to select the assigned number of PSU's, n_{ij}, from each cell receiving a non-zero sample allocation. Sample PSU's within these cells were selected with probabilities proportional to estimated size measures (PPES).

The PPES sampling scheme insured that the probabilities of selecting PSU's within a stratum cell were proportional to the relative sizes of the PSU's within the cell. Departures from strictly PPES probabilities, on an overall basis, were due to the fixed allocations to row and column totals and to the disproportionate allocation to SES strata: these factors were already reflected in the expected sample sizes assigned to each stratum cell. The probability of selection for any PSU may be expressed as:

$$P(u_{ijk}) = \sum_{a} P(u_{ijk} \mid n_{ij} = a)P(n_{ij} = a) . \qquad (4.3)$$

where

$P(u_{ijk})$	probability of selecting PSU-k of cell-ij,
$P(u_{ijk} \mid n_{ij} = a)$	probability of selecting PSU-k of cell-ij, given an allocation a to cell-ij, and
$P(n_{ij} = a)$	probability that a will be allocated to cell-ij

In the process of selecting the sample within a cell, it was necessary to use *working probabilities*, which depended on the realized allocation to the cell as determined by probability sampling of the allocation patterns. If the allocation pattern selected assigned a specific sample size a to a cell, then the working probability (or conditional probability given a) was usually expressed as:

$$P(u_{ijk} \mid n_{ij} = a) = a \frac{S_{ijk}}{S_{ij}} . \qquad (4.4)$$

where

S_{ijk} = estimated size measure for PSU-k of cell-ij, and

S_{ij} = sum of the estimated size measures for all PSU's of cell-ij

For the cases where equation 4.4 was used, equation 4.3 may be restated as:

$$P(u_{ijk}) = E(n_{ij}) \frac{S_{ijk}}{S_{ij}} . \qquad (4.5)$$

where $E(n_{ij})$ is the expected sample allocation to cell-ij in repeated sampling of the sample allocation patterns.

There were two kinds of situations where equation 4.4 was not used: in the self-representing strata and in strata where $(a\,S_{ijk}/S_{ij})$ was greater than one for some allocation a and some PSU-k of cell-ij. For each self-representing stratum, $P(n_{ij} = a) = 1.0$, $P(u_{ijk} \mid n_{ij} = a) = 1.0$, and a was a fixed constant. Thus, by equation 4.3, $P(u_{ijk}) = 1.0$ for each self-representing PSU.

The second situation where formula 4.4 was not used to determine the conditional PSU probabilities was where $(a\,S_{ijk}/S_{ij})$ exceeded 1.0 for one or more PSU's-ijk in cell-ij for one of the two possible values of a. In this situation,

$$P(u_{ijk} \mid n_{ij} = a) = \begin{cases} 1.0 \text{ for } k = k' \\ a\,\dfrac{S_{ijk}}{S_{ij} - S_{ijk'}} \text{ for } k \neq k' \end{cases} \qquad (4.6)$$

was used to determine the working probabilities for PSU's of the cell; and equation 4.3 was used to calculate the overall PSU selection probabilities.

In general, equation 4.3 holds for determining the overall probabilities for any PSU in the sampling frame. Several examples which follow will illustrate the calculation of the working probabilities or conditional probabilities given an allocation a for various situations.

Use of Equation 4.4. The first example (Table 4-27) shows stratum 4613. Since the probability of allocating any PSU to this cell was 0.404 ("Idaho-Major stratum 6," Table 4-25), this cell had

Table 4-27. Hypothetical Example of Primary Sample Selection from Stratum 4613

Frame PSU number	Estimated size	Relative size	Overall probability of selection	Working probability for allocation of 1 PSU	Accumulated working probability
1	1,687	0.3596	0.1453	0.3596	0.3596
2	1,682	0.3586	0.1449	0.3586	0.7182
3	1,322	0.2818	0.1138	0.2818	1.0000
Total	4,691	1.0000	0.4040	1.0000	

possible allocations of zero or one PSU under the controlled selection procedure. The cell contained three PSUs. Table 4-27 shows the estimated size measures, the relative size measures, the overall probabilities of selection, working probabilities for an allocation of one PSU, and accumulated probabilities. Note that the overall probabilities of selection are computed by using equation 4.5 with $E(n_{ij})$ equal to 0.404 and the sum of these probabilities equals 0.404. Working probabilities for an allocation of zero PSUs to the cell (not shown) could be considered zero in this case so equation 4.4 holds for n_{ij} equal to zero. The last column in the table illustrates how the sample PSU was selected when the allocation was one: a random number between zero and one was drawn and compared to the accumulated working probabilities shown. The first PSU with an accumulated working probability equal to or exceeding the random number was selected for the sample; for example, if the random number 0.4562 were drawn, PSU number 2 would have been selected.

Table 4-28 illustrates the calculation of working probabilities when the expected sample allocation was greater than one. In this case, stratum 4244 had a minimum allocation of two PSUs ("Texas-Major stratum 2," in Table 4-24) and a probability of 0.400 of a total allocation of three (Table 4-25). The overall expected sample size was computed using equation 4.5, with $E(n_{ij})$ equal to 2.400. The working probabilities were computed using equation 4.4 with n_{ij} equal to two and three, respectively. It can be verified that the overall probabilities achieved by the primary sampling scheme agree with those shown. The probability that n_{ij} is two (denoted by $P(n_{ij}=2)$), is 0.600; the probability that n_{ij} is three (denoted by

Table 4-28. Hypothetical Example of Sample Selection from Stratum 4244

Frame PSU number	Estimated size	Relative size	Overall probability of selection	Working probabilities 2 PSUs	3 PSUs
1	26,810	0.3275	0.7860	0.6550	0.9825
2	4,457	0.0545	0.1308	0.1090	0.1635
3	5,790	0.0707	0.1697	0.1414	0.2121
4	10,627	0.1298	0.3115	0.2596	0.3894
5	20,040	0.2448	0.5875	0.4896	0.7344
6	14,141	0.1727	0.4145	0.3454	0.5181
Total	81,865	1.0000	2.4000	2.0000	3.0000

$P(n_{ij}=3)$, is 0.400. The overall probability of selection can thus be expressed as:

$$P(u_{ijk}) = P(u_{ijk} \mid n_{ij} = 2)\,P(n_{ij} = 2) + P(u_{ijk} \mid n_{ij} = 3)\,P(n_{ij} = 3)\,.$$

Considering the first PSU listed in Table 4-28, this becomes

$$P(u_{ijk}) = (0.6550)(0.600) + (0.8825)(0.400) = 0.7860\,.$$

This compares with the value shown in the overall probability column. Overall probabilities for the remaining PSUs may be similarly verified.

The actual selection of PSU's in a cell with an allocation of two or more PSU's was performed using a method called *unequal probability sampling without replacement*. Several procedures[1] are available for drawing such samples. The one used for the NAEP year 02 sample was a serial selection procedure which can be easily programmed for electronic computers and is generally applicable to any sample size if the normal constraints for defining the selection probabilities between zero and one are met.

Continuing with the hypothetical example for stratum 4244, suppose that three PSU's were assigned to this stratum cell as a result of the controlled selection allocation procedure and that applications of the unequal probability sampling without replacement procedures resulted in the selection of PSU's 2, 5, and 6 (Table 4-28). For statistical estimation purposes, the overall selection probabilities for these PSU's would be as 0.1308, 0.5875, and 0.4145, respectively.

Use of Equation 4.6 Table 4-29 illustrates the calculation of working probabilities for one of the cases when equation 4.6 was used to assign the working probabilities. In this case, stratum 1422

Table 4-29. Hypothetical Example of Sample Selection from Stratum 1422

Frame PSU number	Estimated size	Relative size	Overall probability of selection	Working probabilities: 1 PSU	Working probabilities: 2 PSU's
1	10,020	0.2433	0.3731	0.2433	0.5088
2	21,500	0.5219	0.7557	0.5219	1.0000
3	9,672	0.2348	0.3602	0.2348	0.4912
Total	41,192	1.0000	1.4890	1.0000	2.0000

had a minimum allocation of one PSU with probability 0.511, a maximum allocation of two PSU's with probability 0.489, and an expected allocation in repeated sampling of 1.489 PSU's ("Massachusetts Major stratum 1," in Table 4-20). The working probabilities for an allocation of one PSU were computed using equation 4.4; but equation 4.6 was used to determine the working probabilities for the allocation of two PSU's. The overall probabilities for the three PSU's computed using equation 4.3, added to 1.489, is the expected sample size for the stratum.

Using the overall selection probabilities to produce the estimates required by National Assessment is discussed in chapter 8. The next chapter describes the selection of sample schools within the PSU's.

WORKS CITED IN CHAPTER 4

1 P. V. Sukhatme and B. V. Sukhatme. *Sampling Theory of Surveys With Applications.* 2nd ed. Ames, Iowa: Iowa State University Press, 1970.

CHAPTER 5

THE SCHOOL SAMPLE WITHIN PSUs

Introduction

The primary sample selection was described in chapter 4. The procedures used to construct the school sampling frame and to select the sample schools are discussed in this chapter. Selecting and assigning the sample students to particular assessment packages are discussed in chapter 6.

The within-PSU sampling requirements for National Assessment are summarized as follows:

1. The school sample must contain a sufficient number of eligible students for all planned package sessions to be administered.
2. The school frame must include measures of the SES level of each school for stratification by SES within all PSUs and for oversampling low SES schools in SOCs 1 and 2.
3. The year 02 selection procedure must minimize the reselection of schools selected in year 01.
4. A supplemental sampling procedure must be developed for schools with small numbers of eligibles enrolled.
5. Probability sampling must be used to obtain approximately equal student probabilities of selection except that low SES students must be sampled at about twice the sampling rate for high SES students.
6. Students within any one-week PSU must be selected from at least two schools, in any two-week PSU, from at least four schools.

Constructing the Second-Stage Sampling Frame

The School Frame

In each selected PSU, it was necessary to obtain a complete list of all elementary and secondary schools (public and private). Special schools for the mentally or physically handicapped and penal institutions were excluded. The basic data required for each school included the school name, the address (including zip code), the grade range, and the enrollment.

The most useful sources for school lists were state directories of education; most were available annually, and some listed nonpublic as well as public schools. Additional data sources for nonpublic

schools were the Official Catholic School Directory (published annually) and the Office of Education Directory of Non-Public Schools (Fall 1968). Directories published by some large city districts were used and, in a few cases, local school officials provided specially prepared lists. Thus, the sampling frame was based on various school lists, most of which were about one year old. Updating procedures were built into the field operation to identify new schools opening in the sample districts (see last section of this chapter).

School Size Measures

The sampling frame for each age group consisted of all schools containing certain grades: 9-year-olds, grades 2, 3, 4, and 5; 13-year-olds, grades 6, 7, 8, and 9; and 17-year-olds, grades 9, 10, 11, and 12. Schools without the grades listed above were not eligible for the sample for that age group. For example, K-8 (kindergarten through grade 8) schools were assumed to have no eligible 17-year-olds. Any school with one or more of the grades 2 through 5 was eligible for selection in the sample for 9-year-olds; similarly, all schools with any of the grades 6 through 9 were eligible for the 13-year-old sample, and schools with any of the grades 9 through 12 were eligible for the 17-year-old sample. However, some students outside these grade ranges were selected because all age-eligible students in each sample school were eligible for assessment. Table 5-1 shows the distribution of the total U.S. enrolled population in each age group and grade for 1960. Both 16-year-olds and 17-year-olds are shown since National Assessment defined 17-year-olds as students from 16-1/2 to 17-1/2 years of age.

The grade range and enrollment data for each school in the PSU were used along with state total enrollments by age and grade (1960 Census data) to estimate each school's enrollment for three age groups the 9-year-olds, 13-year-olds, and 17-year-olds. Total enrollments were available in most cases, but in four states (North Carolina, Tennessee, Georgia, and Florida) these were estimated by multiplying the number of teachers for each school by the state average student-teacher ratio. The equation used to compute the estimated age-k enrollment in school-j, $\hat{Y}_{kj}$, was:

$$\hat{Y}_{kj} = Y_j \frac{\sum_{i=l}^{h} X_{ik}}{\sum_{i=l}^{h} X_i} . \qquad (5.1)$$

where

Y_j = total enrollment in school-j,
l = lowest grade in school-j,
h = highest grade in school-j,
X_{ik} = 1960 Census age-k state enrollment in grade-i, and
X_i = 1960 Census grade-i state enrollment

The procedures for obtaining age enrollment estimates by school were crude but adequate since the final allocation of the student sample to schools was delayed until more up-to-date, grade-by-grade enrollment data were obtained from each sample school (chapter 6).

Table 5-1. Grade Distribution of Age Groups Enrolled in School, U.S.

Grade	9-year-olds (percent)	13-year-olds (percent)	16-year-olds (percent)	17-year-olds (percent)
K	--	--	--	--
1	0.8	0.1	0.2	0.2
2	5.7	0.1	0.3	0.3
3	36.3	0.3	0.4	0.3
4	53.5	0.8	0.1	0.2
5	3.4	2.3	0.3	0.2
6	0.3	8.1	0.5	0.3
7	0.1	34.5	1.2	0.6
8	--	49.1	3.2	1.5
9	--	4.0	8.8	3.1
10	--	0.6	30.2	8.2
11	--	0.2	49.4	31.8
12	--	--	4.9	50.7
College, etc	--	--	0.3	2.6
	100.0	100.0	100.0	100.0

Source: *1960 Census of Population*

School SES Indices

A socioeconomic status (SES) variable based on 1960 Census income data for census tracts (CTs) and minor civil divisions (MCDs) was used as a relative SES index for schools within PSUs. In some large metropolitan areas, Office of Economic Opportunity (OEO) poverty maps were used to identify areas as low SES, high SES, or mixed (intermediate).

Regardless of the source of the data, the general approach was to

use the zip code to identify each school with local area data. Zip code maps were compared to CT maps or MCD maps and the percentage of families earning less than $3,000 per year was computed for each zip code area from either CT or MCD tabulations. Relative measures of the percentages of families earning less than $3,000 were used based on the poverty areas shown on the OEO maps when these maps were available.

These procedures assume that the school location is a good indicator of the SES level of its students; this assumption is not always correct for secondary schools which serve large areas or for school systems transporting pupils to different neighborhoods in the same districts.

Clustering Schools

In relatively small PSU's, schools themselves were the second-stage sampling units (SSU's). In most of the large PSU's, local area schools were clustered as SSU's to reduce the number of school districts or other administrative units in the sample and to reduce travel costs between sample schools in the same PSU.

Each SSU was formed by combining adjacent zip code areas until a minimum size requirement (500 students for each of the three age groups) and a minimum school requirement (two schools with relatively large enrollments from each age group) were satisfied. These minimums were met by schools not selected in the year 01 sample.

Stratification by SES

The SSU's (either schools or school clusters, depending on the PSU size) were stratified into two SES strata based on the SES indices for the PSU's. Those with the largest proportion of low-income families were put in the low SES stratum, and the others made up the high SES stratum. The secondary strata in PSU's from SOC's 3 and 4 were defined to be about equal in total enrollments. The low SES secondary stratum in PSU's from SOC's 1 and 2 was defined as about one-third, and the high SES stratum as the remaining two-thirds of the PSU enrollment. Selecting equal samples from each secondary stratum enabled the low SES schools in SOC's 1 and 2 to be sampled at about twice the rate of the high SES schools.

Table 5-2 shows the size measures for the seven SSU's of a hypothetical SOC 1 PSU, ranked by SES index. SSU's 1, 2, and 3 were defined as the low SES stratum and SSU's 4, 5, 6, and 7 as the high SES stratum. A higher SES index indicates a high proportion of low-income families thus, low SES. The total enrollments and

Table 5-2. Secondary Sampling Unit (SSU) Summary for a Hypothetical SOC 1 PSU

SSU number	SES index	Total enrollment	Estimated 9-year-olds	Estimated 13-year-olds	Estimated 17-year-olds
7	0.23	24,399	1,896	2,008	1,340
5	0.23	7,889	520	603	614
4	0.24	12,472	967	1,083	625
6	0.24	13,688	1,111	925	868
3	0.24	11,707	1,011	850	608
2	0.32	10,904	923	909	552
1	0.36	14,686	1,250	1,268	633
PSU total		95,745	7,678	7,646	5,240

Table 5-3. Secondary Stratum Size Measures for Hypothetical SOC 1 PSU

Secondary stratum	Enrollment		9-year-olds		13-year-olds		17-year-olds	
	Total number	% of total	Total number	% of total	Total number	% of total	Total number	% of total
1. low SES	37,297	39.0	3,184	41.5	3,027	39.6	1,793	34.2
2. high SES	58,448	61.0	4,494	58.5	4,619	60.4	3,447	65.8
Total	95,745	100.0	7,678	100.0	7,646	100.0	5,240	100.0

estimated size measures, aggregated to the stratum level, are shown in Table 5-3 to illustrate the relative sizes of the two strata within this example PSU.

Selecting Sample SSUs

In large-population PSU's where SSU's were clusters of schools, two sample SSU's (one low SES and one high SES) were selected for each of the three age groups samples. This section describes the procedures used to select two SSU's for each PSU. The procedure used for small-population PSU's where clusters of schools were not constructed is described in the next section.

For each SSU, measures of size were the estimated numbers of 9-year-olds, 13-year-olds, and 17-year-olds. A probability proportional-to-estimated size sample (PPES) was needed for each age group. It was considered desirable to select the same SSU for all age groups to reduce travel costs, but the relative size measures for the three age groups were generally unequal. A procedure developed by Keyfitz[1] was modified to select sample SSU's with PPES for each age group and, at the same time, to maximize the probability of selecting

the same SSU for 9- and 13-year-olds and for 9- and 17-year-olds. First, one SSU was selected in each stratum for the 9-year-old sample, using PPES sampling. The conditional probability of selecting the i-th SSU for the 9-year-old sample (denoted $P_{9,i}$) in a secondary stratum given that the associated PSU was selected at the primary sampling stage can be expressed as:

$$P_{9,i} = \frac{S_{9,i}}{\sum_i S_{9,i}} \tag{5.2}$$

where $S_{9,i}$ is the estimated number of 9-year-olds in SSU i. Table 5-4 shows the values of $P_{9,i}$ (calculated from the $S_{9,i}$ values, Table 5-2) for the three SSUs in the low SES stratum of the example PSU. The sample SSU for this stratum was selected by comparing a uniform random number* with the accumulated $P_{9,i}$ values shown in the table.

Table 5-4. SSU Selection Within Low SES Stratum of a Hypothetical PSU

SSU No. i	$P_{9,i}$	Accumulated $P_{9,i}$	$P_{13,i}$	Max $(0, P_{13,i} - P_{9,i})$	W_i	Accumulated W_i
1	0.392	0.392	0.419	0.027	0.730	0.730
2	0.290	0.682	0.300	0.010	0.270	1.000
3	0.318	1.000	0.281	0.000	0.000	1.000
	1.000		1.000	0.037	1.000	

To select the sample SSU for the 13-year-old sample, similar probabilities were computed and denoted by $P_{13,i}$ (see Table 5-4). The next step was to compare $P_{13,i}$ with $P_{9,i}$ where the i-th unit was selected for the 9-year-old sample. If $P_{13,i}$ was equal to or greater than $P_{9,i}$, the i-th SSU was automatically included in the 13-year old sample; otherwise, a working probability, W_i was computed as:

$$W_i = \frac{P_{13,i}}{P_{9,i}} \tag{5.3}$$

*Decimal number from 0.001 to 1.000

The value W_i was compared with a uniform random number, R, selected from a random number table. If W_i was less than R, the i-th SSU was included in the 13-year-old sample; if not, another SSU was selected for the 13-year-old sample using working probabilities W'_i.

$$W'_i = \frac{\text{Max}\{0, P_{13,i} - P_{9,i}\}}{\sum_i \text{Max}\{0, P_{13,i} - P_{9,i}\}} \qquad (5\text{-}4)$$

where

$\text{Max}\{0, P_{13,i} - P_{9,i}\} = 0$ if $P_{9,i} > P_{13,i}$ for SSU-i and $P_{13,i} - P_{9,i}$ otherwise.

Table 5-4 also shows the calculated values of the $P_{13,i}$, the $\text{Max}\{0, P_{13,i} - P_{9,i}\}$, and the W'_i for the three SSU's of the example stratum. Using the above procedure, the probabilities of selection for the three SSU's may be verified as follows:

$$P_{13,1} = P_{9,1} + P_{9,3}(1 - W_3)W'_1 = 392 + 318(1 - \frac{281}{318})(.730) = 419.$$

$$P_{13,2} = P_{9,2} + P_{9,3}(1 - W_3)W'_2 = 290 + 318(1 - \frac{281}{318})(.270) = 300$$

$$P_{13,3} = P_{9,3}W_3 = 318(\frac{281}{318}) = 281$$

The same procedure was used to maximize the probability of selecting the same SSU for the 9-year-old and 17-year-old samples.

The School Sample Within SSUs

Usually, but not always, the procedures used resulted in selection of the same SSU for all three age groups. In cases where the PSU was not first divided into several SSU's within each SES stratum, the entire stratum was considered the SSU selected with probability one. This allows us to discuss selection of schools within SSUs in general. In all cases, the sample schools for the three age group samples were selected independently within the selected SSUs.

In each two-week PSU, the sampling plan called for two

group-administered sessions for each package, with 12 students participating in each session. Since an equal sample was allocated to each secondary stratum, the planned sample in each selected SSU called for one administration of each group package. Before selecting the sample schools, several substrata were formed within SSU's based on the estimated number of eligibles within each school. Then, the total sample for the SSU was allocated to these substrata, school selection probabilities were assigned within substrata, and the sample schools were selected.

Initial Sample Allocation to Schools

Table 5.5 illustrates a listing of all schools eligible for the 13-year-old sample selection in an SSU. The listing includes the grade range, the total enrollment, and the estimated number of 13-year-olds for each school. The number of 13-year-olds are accumulated in the next two columns. The initial accumulation includes all 13-year-olds; the adjusted accumulation excludes schools with less than 25 students.

In Table 5.5, the column headed "Maximum group packages" needs special explanation. One within-PSU requirement was that probability sampling be used to obtain nearly equal selection probabilities within SOC's 3 and 4 and to oversample students in low SES schools for SOC's 1 and 2. Accordingly, consideration was given to the school probability of selection and the anticipated student probability of selection within sample schools. The anticipated student probabilities were based on the number of group package sessions assigned to the school. (Individual package sessions were assigned automatically [see chapter 6] on the basis of the group package assignments.) Because of the alternates and the associated individual package sessions, about 22 students were required for each package assigned to a school. The maximum allocation of group package sessions to each school was determined by dividing the estimated number of 13-year-olds by 25 and dropping the remainder. Schools with fewer than 25 students were tentatively set up for a special supplemental package to be administered to most or all eligibles. Seven of the 17 schools listed in Table 5.5 had a "0" maximum (the supplemental package category); five schools had sufficiently large enrollments for one group package session; three schools, for two sessions; one school, for three sessions; and one school, for five sessions.

In year 02, 13 group packages were used for the 13-year-old age group. The columns headed "Accumulated package allocation" show the accumulated proportional allocation of the 13 group package sessions to the 17 schools. The initial accumulation includes all

Table 5-5. School Frame for 13-Year-Olds in a Selected SSU*

School ID	Grade range	Total enrollment	Total No.	13-year-olds Accumulated Initial	13-year-olds Accumulated Adjusted	Maximum group packages	Accumulated package allocation Initial	Accumulated package allocation Adjusted	Year 01 code	Pr(School | SSU)
500002	1-7	9	1	1	--	0	0.020	--	0	0.03636
500003	9-12	159	2	3	--	0	0.060	--	0	0.07273
203012	1-6	175	3	6	--	0	0.120	--	0	0.10909
202002	9-12	700	8	14	--	0	0.280	--	0	0.29091
203003	1-6	450	9	23	--	0	0.459	--	0	0.32727
203004	9-12	1,025	11	34	--	0	0.679	--	0	0.40000
202006	1-8	200	21	55	--	0	1.098	--	0	0.76364
202004	1-12	325	27	82	27	1	1.637	0.589	0	0.59669
202005	1-8	300	32	114	59	1	2.276	1.267	0	0.70718
202002	1-8	300	32	146	91	1	2.916	1.985	0	0.70718
203007	1-8	425	45	191	136	1	3.814	2.966	0	0.99448
203009	1-8	425	45	236	181	1	4.713	3.948	0	0.99448
203002	1-8	475	51	287	232	2	5.731	5.060	0	0.56983
203011	1-8	525	56	343	288	2	6.849	6.282	0	0.62570
201006	1-12	850	72	415	360	2	8.287	7.852	0	0.80447
203005	4-12	775	94	509	454	3	10.164	9.903	0	1.00000
203008	7-8	350	142	651	596	5	13.000	13.000	0	1.00000

* Summary of allocation to size strata:

Stratum No.	Trial package allocation	Schools listed	Sample schools	Total packages
1	Supplemental package	7	2	–
2	1 per school	5	4	4
3	2 per school	3	2	4
4	2 per school	1	1	2
5	3 per school	1	1	3
Total		17	10	13

schools; the adjusted excludes the schools with low enrollments, which were administered supplemental packages.

Stratification by Size of School

The accumulated package allocation data were used to determine the size-of-school stratification and to decide how many schools should be selected from each stratum. The size-of-school strata ensured that the sample would contain schools with sufficient enrollments for the administration of all the required package sessions and that the selection probabilities would be approximately equal for students within each SSU.

In order to do this, the school probabilities of selection were not set strictly proportional to estimated size but also depended upon the anticipated number of group packages assigned to the school. Trial package allocations were made at the school selection stage in order to set the school probabilities realistically. The final package allocations (chapter 6) were not limited by the trial allocations. If age enrollment distributions were, in fact, different from the estimates used for school selection, the final package allocations were adjusted to more nearly achieve equal student selection probabilities. To illustrate the point, the probability of selecting a student, given that the SSU is in the sample, may be written as:

$$P(\text{Student}|\text{SSU}) = P(\text{School}|\text{SSU}) \cdot P(\text{Student}|\text{School}), \qquad (5.5)$$

which is the conditional probability of the school given the SSU, multiplied by the conditional probability of the student given the school.

For each group package assigned, 12 students were selected for the group session and two students for associated individual packages. (The association of individual and group package assignments is explained in chapter 6.) The probability of a student given the school can be written as a function of both the school's enrollment in the age group, S, and the total number of group packages, G, assigned to the school:

$$P(\text{Student}|\text{School}) = \frac{14G}{S} \qquad (5.6)$$

The adjusted accumulated package allocations and the trial allocations were used to achieve more nearly equal student selection probabilities within SSU's. This was done by partitioning the SSU school sampling frame into strata by feasible trial allocations based on the "Maximum group packages" (Table 5-5) and by selecting a

sufficient number of schools within the stratum, using PPES sampling, to coincide approximately with the accumulated proportional package allocation. Exact coincidence with proportional package allocation was not feasible since an integer number of group packages was assigned to each stratum. Size-of-school stratification is shown in Table 5-5 by lines drawn across the table. Trial package allocations and sample sizes for the school selection are summarized at the bottom of the table. In addition to two schools selected for possible use in the supplemental sample, the trial allocations for the sample schools add up to 13 group packages (four schools from stratum 2 received one group package each, two schools from stratum 3 received two each, one from stratum 4 received two, and one from stratum 5 received three). The accumulated stratum trial package allocations are similar to the adjusted accumulated package allocations shown in the frame listings (i.e., 4 compares with 3.948, 8 with 7.852, 10 with 9.903, and 13 with 13.000).

For the SSU shown in Table 5-5, a sample of 10 schools was required to assign the 13 packages and to meet the sampling requirements. Ten is more schools than was usually required, but the number of sample schools may be quite high if a large number of group packages are to be administered.

The final allocation of packages to schools was based on current enrollment and other data supplied by the school prior to assessment. The trial allocation procedures at the school selection stage were only guides to determine how many schools to select; this was then used to determine the school probabilities of selection.

Selecting the Sample Schools

After the stratum sample sizes were determined (bottom of Table 5-5), the sample schools were selected using PPES sampling procedures. The estimated size measures used were the preliminary estimates of the number of 13-year-olds. The last column in Table 5-5 shows the conditional probabilities of selection for each school in the SSU, given that the SSU was selected for the sample. These probabilities were assigned by multiplying the school's estimated 13-year-olds by the stratum sample size and dividing by the total estimated 13-year-olds in the stratum (e.g., for school 202005, $4 \times 32 \div 181 = 0.70718$).

Random number tables were used to select one school from a size stratum with PPES. A serial selection procedure was used when two or more schools were to be selected.

One of the within-PSU sampling requirements was that reselection of year 01 sample schools was to be avoided in year 02 to the extent possible. This was considered necessary in order to minimize

the burden on school staff and to maximize the school cooperation rates. Year 01 sample schools were identified in the school sampling frame for each selected PSU prior to selecting year 02 sample schools. In Table 5-5, the column headed "Year 01 code" indicates that none of the schools in the PSU had been selected in the year 01 sample [illegible]

When only one sample school was allocated to a size stratum within an SSU, random numbers were drawn repeatedly until a school with a zero year 01 code was selected. When two or more schools were allocated to a size stratum, n' (equal to $n + N_1$) schools were first selected with PPES, where n is the number of year 02 sample schools allocated to the stratum, and N_1 is the number of year 01 schools in the stratum. Secondly, $(n' - n)$ of the n' selected schools were randomly deleted with equal probabilities; any year 01 schools included in the n' selected schools were automatically deleted. In a few PSU's, there were so many year 01 schools in the PSU that it was not possible to avoid reselecting them in some strata, so a few year 01 schools were reselected.

Special Selection Procedures for Small Schools

In the previous example, two schools were selected for the supplemental package sample, and a school sample with sufficiently large estimated enrollment for one administration of each group package was selected in each SSU. Schools with small estimated enrollments (less than 25 eligibles) were assigned appropriate selection probabilities and were assigned supplemental packages. Every eligible school had a positive probability of selection. This section discusses the procedure used to assign selection probabilities to schools with small enrollments. To illustrate two typical situations, a new example (Table 5-6) is discussed first, followed by a discussion of the previous example (Table 5-5).

In the example shown in Table 5-6, two schools had small estimated enrollments of 17-year olds. The initial accumulated group package allocation for the two schools is 0.049. Assuming 14 students are selected for the sample as a result of the allocation of one group package session (12 students for the group package session and two for the associated individual packages sessions), the 0.686 (0.049 x 14) students should be selected to achieve comparable student probabilities of selection in this first size stratum. An expected (average) sample size of 0.686 students can be selected if probability sampling methods are used to, first, determine if one school is to be selected and, if so, to select the school with an appropriate selection probability. If it is assumed that estimated enrollments (4 and 5) are correct, that all students would be selected

Table 5-6. School Frame for 17-Year-Olds in a Selected SSU*

School ID	Grade range	Total enrollment	17-year-olds: Total No.	17-year-olds: Accumulated Initial	17-year-olds: Accumulated Adjusted	Maximum group packages	Accumulated package allocation: Initial	Accumulated package allocation: Adjusted	Year III code	P School SSU
240004	7-9	778	4	4	--	0	0.022	--	0	0.00711
240012	7-9	940	5	9	--	0	0.049	--	0	0.00889
500180	8-12	323	53	62	53	2	0.337	0.289	0	0.26238
500189	9-12	335	73	135	126	2	0.733	0.688	0	0.36139
500096	9-12	351	76	211	202	3	1.146	1.103	0	0.37623
500118	9-12	1,130	246	457	448	9	2.482	2.448	0	0.30184
240014	10-12	980	283	740	731	11	4.020	3.990	0	0.34724
240002	10-12	1,124	324	1,064	1,055	12	5.779	5.750	0	0.39755
240020	10-12	2,692	777	1,841	1,832	31	10.000	10.000	0	0.95337

* Summary of allocation to size strata

Stratum No.	Trial package allocation	Schools listed	Sample schools	Total packages
1	Supplemental package	2	Expectation of 0.15	--
2	1 per school	3	1	1
3	4 or 5 per school (4.1-2)	4	2	9
Total		9		10

if the school were selected, and that if one of the two schools is selected, it will be selected with PPES (using conditional probabilities of 4/9 and 5/9, respectively), then the expected student sample size, $E(n_1)$, for the supplemental stratum may be written as:

$$E(n_1) = \lambda \cdot [4 \cdot (4/9) + 5 \cdot (5/9)], \qquad (5.7)$$

where λ is the probability of selecting one school from the stratum and $(1 - \lambda)$ is the probability of selecting no school in the stratum.

If $E(n_1)$ is set at 0.686 students, it is possible to solve for:

$$\lambda = 0.686 / [4 \cdot (4/9) + 5 \cdot (5/9)] = 0.151 \qquad (5.8)$$

The sample selection was a two-step procedure. First, a uniform random number, R, between 0 and 1 was selected and compared with 0.151. If R was greater than 0.151, no school was selected from the stratum. If it was less than 0.151, one school was selected with PPES. The school selection probabilities, given that the SSU has been selected, were computed as 0.151 times 4/9 and 0.151 times 5/9, respectively (Table 5-6).

A similar approach with stratum 1 of Table 5-5, assuming that no more than 12 students could be selected in any sample school, yielded the following solution for λ, where $E(n_1) = 1.098 \cdot 14 = 15.372$:

$$\begin{aligned} \lambda &= 15.372 / [1 \cdot (1/55) + 2 \cdot (2/55) + 3 \cdot (3/55) + 8 \cdot (8/55) \\ &\quad + 9 \cdot (9/55) + 11 \cdot (11/55) + 12 \cdot (21/55)] \\ &= 15.372 / 9.673 \qquad (5.9) \\ &= 1.589 \end{aligned}$$

In this case, λ was not interpreted as a probability but as the approximate number of schools to select from the stratum. General guidelines for determining the sample size for supplemental package stratum were to select one school with certainty if λ was between 1 and 1.5 and to select two schools with certainty if λ was greater than 1.5.

For the supplemental package stratum, the size measures were estimates based on total enrollments of previous years, so approximations for λ were used in most cases. Once the school selection probabilities were assigned, however, *exact* procedures were followed so that unbiased estimation of means and totals would be possible.

By employing similar procedures independently in all sample SSU's, a probability sample of the small schools was obtained, and thus inferences can be made from the National Assessment statistics to students in all eligible schools.

Probability Sampling Procedures for Schools Not in the Initial Frame

A computer printout, including the school address, the principal's name, and the district superintendent's name for each sample school, was prepared for each PSU. Introductory letters and lists of sample schools were mailed to the superintendents and private school officials involved. The district supervisor (DS)* in charge of conducting National Assessment followed up with a telephone call to discuss the assessment in the PSU, to obtain a list of new schools in the district, and to note any schools selected for the sample that had closed or changed their operation. Information on school closings and new schools was relayed to the sampling staff, who dropped closed schools from the list and selected a sample of new schools in the PSU. If schools identified by the DSs were not found in the initial frame, they were listed in a special "new school" sampling frame.

Since the new schools were identified through district superintendents, it was necessary to determine the probability of selecting a particular district in the selected PSU. If the entire PSU consisted of a few large school districts (no more than two or three large districts), the district probabilities were assumed to be one. When the PSU consisted of several small districts with one or two schools each (e.g., one elementary and one secondary school), the district probability was assumed to be approximately the same as the school probability.

Each new school was assigned a probability of selection, P(School PSU), consistent with assigned school probabilities of approximately equal age enrollments in the original sampling frame. If the district probability was less than one, the conditional probability of selection was assigned to satisfy the following condition:

$$P(\text{School PSU}) = P(\text{District PSU})\, P\,(\text{New School District}).$$

A uniform random number, R, between zero and one was then selected; if R was less than P(New School District), the new school was included in the sample and its conditional probability of selection given the PSU was recorded as P(School PSU).

*Each DS of the professional field staff for the project was assigned about four PSUs. The term DS is not associated with any school district.

Procedures used to select students within sample schools are discussed in the next chapter.

WORKS CITED IN CHAPTER 5

[illegible] Sampling with Probabilities Proportional to Size: Adjustment for Changes in Probabilities," Journal of the American Statistical Association, Vol. [illegible], [illegible].

CHAPTER 6

THE WITHIN-SCHOOL SAMPLE

Introduction

The selection of sample PSU's and sample schools was discussed in chapters 4 and 5. The procedures followed to update the enrollment and SES information for sample schools, to allocate the planned sample for each package to schools, and to select the samples of students are discussed in this chapter.

Updating Sample School Information

District supervisors (DSs) met with the school principals of each PSU to set up an assessment timetable and to make other preassessment preparations. The principals received questionnaires (Figure 6-1) in the mail and brought them to the meeting. An updated size measure and an updated SES index for each sample school were computed from the principal's responses to questions 1, 3, 4, and 6 of the School Principal's Questionnaire (Figure 6-1). The updated size and SES measures were used to allocate the sample to schools.

Size Measures

Schools were initially selected based on size measures computed from school grade ranges and total enrollments for the previous year (chapter 5, equation 5.1). These estimates were updated using the current grade enrollments given on the School Principal's Questionnaires. Parameters for converting the grade enrollments to age enrollment estimates were obtained from 1960 Census data for each state. The equation used to estimate $\hat{Y}_{kj}$, the age-k enrollment in school-j, was:

$$\hat{Y}_{kj} = \sum_{l} Y_{jl} \cdot \left(\frac{X_{lk}}{X_{l}} \right), \qquad (6.1)$$

where

Y_{jl} = total grade-l enrollment of school-j,

X_{lk} = 1960 Census age-k enrollment in grade-l for the state,

X_{l} = 1960 Census grade-l enrollment for the state, and

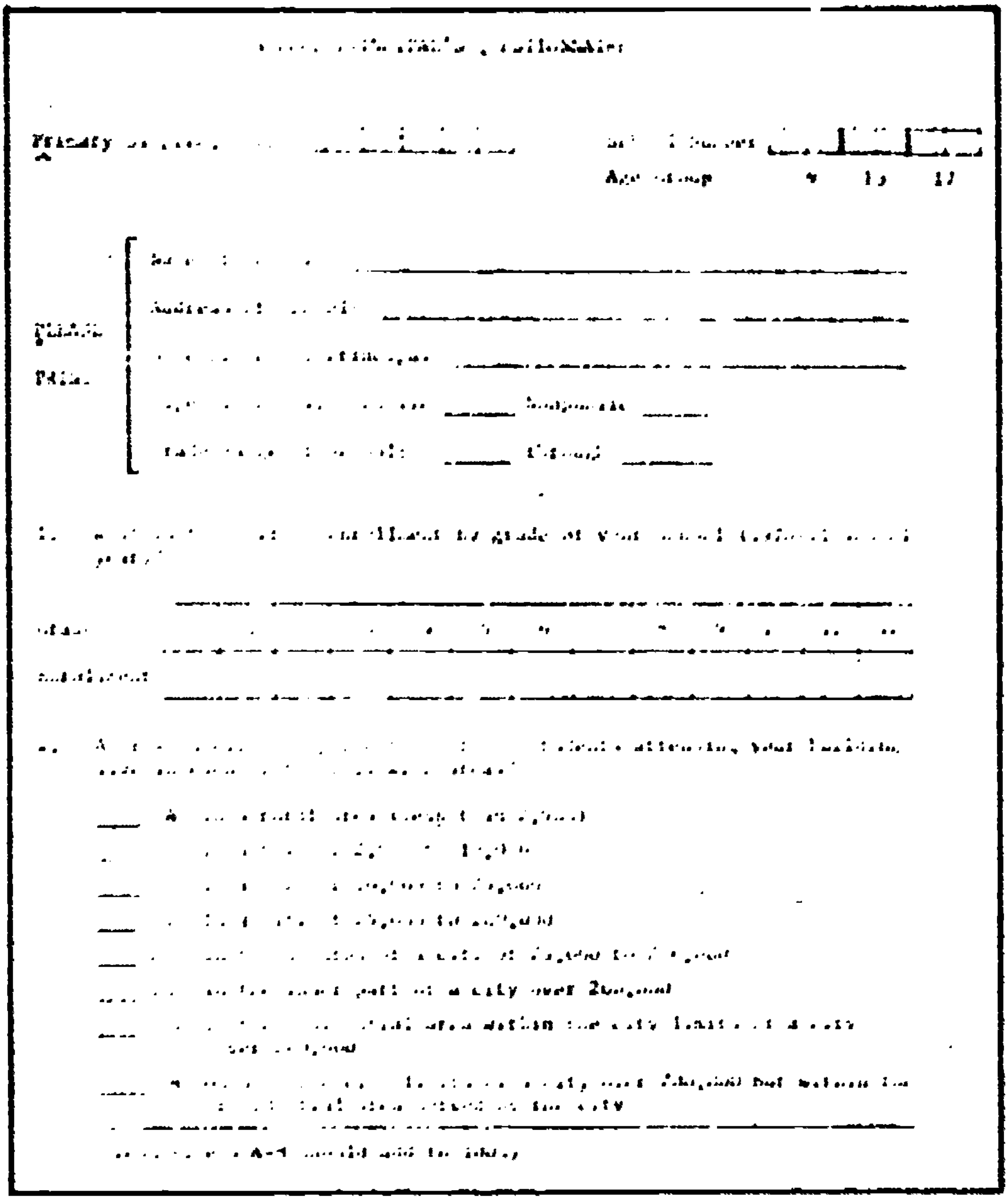

Figure 6-1. Example of questionnaire mailed to school principals.

-2-

3. [illegible] what percentage of the students attending your building are children of

____ A. [illegible] managerial personnel

____ B. Sales, clerical, technical or skilled workers

____ C. [illegible] other blue collar workers

____ D. [illegible] workers

____ E. Not regularly employed

____ F. On welfare

[illegible] should add to 100 %

4. Approximately what percentage of your students are white? (Check one)

____ A. [illegible]	____ G. 50-59%
____ B. [illegible]	____ H. [illegible]
____ C. [illegible]	____ I. 70-79%
____ D. [illegible]	____ J. 80-89%
____ E. [illegible]	____ K. 90-99%
____ F. [illegible]	____ L. All

5. [illegible] have "split" or modular sessions?

____ Yes

____ No

If "Yes," please explain schedule briefly ____________________

6. [illegible] qualify for ESEA Title I assistance?

____ Yes

____ No

7. What is your name and title?

____
(Name)

____
(Title)

Figure 6-1. (continued). Example of questionnaire mailed to school principals.

$$j = \begin{cases} 2,\ 3,\ 4,\ 5 & \text{for } k = 9 \\ 6,\ 7,\ 8,\ 9 & \text{for } k = 13 \\ 9,\ 10,\ 11,\ 12 & \text{for } k = 17 \end{cases}$$

The age enrollment estimation procedure is illustrated with a hypothetical school in Alabama. If a junior high school reported enrollments of 65, 75, and 50 in grades 7, 8, and 9, respectively, and the Alabama proportions for estimating 13-year-old size measures were 0.4506, 0.3726, and 0.0353 for those grades, the estimated school size measure, $\hat{Y}_{13,j}$, using equation 6.1, would be:

$$\hat{Y}_{13,j} = 65(0.4506) + 75(0.3726) + 50(0.0353) = 59$$

In some cases, the principal supplied a specific number of age eligibles for his school at the preassessment meeting. These numbers were used instead of estimates (equation 6.1) for those schools.

The SES Index

An initial SES index (S) based upon 1960 Census income data for census tracts (CTs) and minor civil divisions (MCDs), and in some cases on Office of Economic Opportunity (OEO) poverty area maps, was used to rank the schools within each PSU on a relative scale at the school selection stage (chapter 5). The updated SES index (I), a combination of the SES index used for school selection and responses to questions 3, 4, and 6 on the Principal's Questionnaire (Figure 6-1), was computed as:

$$I = \frac{S + \sum_{i=1}^{6} (C_{3i}P_i) + C_{4i} + (100C_{6k})}{1 + N} \tag{6.2}$$

where

C_{3i} = 0.0, 0.2, 0.4, 0.6, 0.8, 1.0 for i = 1, 2, 3, 4, 5, 6, the responses to question 3 of the questionnaire.

P_i = The percentage reported in category i (i = 1-6) of question 3 of the questionnaire;

C_{4i} = 100, 95, 85, . . . , 15, 5, 0 for i = 1, 2, 3, . . . , 12, or not answered, the indicated response to question 4 of the questionnaire;

C_{6k} = $\begin{cases} 1 \text{ if question 6 was answered "yes"} \\ 0 \text{ if question 6 was answered "no", or not answered;} \end{cases}$

N = the number of questions 3, 4, and 6 answered by the school principal.

The new SES index assumes large values for schools with large values of the previous SES index, large percentages of low-income parent's occupations, and large percentages for black students and for schools qualified for Title I assistance. High values indicate a relatively high proportion of poverty among the population served by the school (thus, a low SES school). However, since the SES index was merely a guide to sample allocation, it is not a true measure of the proportion of low SES students in the school.

Allocating Packages to Schools

The survey plan did not allow for transporting students between schools to form group sessions; therefore, the sampling procedure was designed so that a school in each one-week PSU or a pair of schools in each two-week PSU was selected for each group package. After allocating the total group administrations to schools, the specific group packages assigned to each school were determined by a random permutation method.

Efficient sample design dictated spreading the PSU's sample for each individually administered package over most of the sample schools. Allocation of the individually administered packages was coordinated with allocation of group packages so that the total sample would be spread across all sample schools and so that no student would be required to participate in more than one package administration. The simultaneous allocation of all group and individual package administrations was achieved by allocating sample students to schools in multiples of students comprised of 12 students for a group session, plus two or three students for individual package administrations.

In primary SOC strata 1 and 2, the packages were allocated so that low SES schools were oversampled based on the updated SES index. The oversampling of low SES schools did not depend on how they were classified at the time of school selection. In primary SOC strata 3 and 4, low SES schools were not oversampled within PSUs; the SES index was used as stratification variable. Sample allocation within the constraints of the low SES oversampling requirement achieved nearly equal probabilities of selection for all students within each PSU (SOC's 3 and 4) or for all students in each SES stratum within the PSU (SOCs 1 and 2).

Total Group Administration

Table 3-3 (chapter 3) shows the number of group packages and the planned sample size per package in each PSU for each age group. The total number of group administrations (e.g., 18 for 9-year-olds,

26 for 13-year-olds, and 20 for 17-year-olds for each two-week PSU) were allocated to sample schools, along with a number of individual package administrations.

An example allocation of the planned sample for 17-year-olds in a two-week PSU is presented to illustrate the procedure. Table 6-1 lists the schools in the 17-year-old sample for a hypothetical SOC 2 PSU in descending order according to the updated SES index (i.e., lowest SES-level schools first). Updating the SES index often changed the SES classification of schools from that used for school selection; for example, school 66 for sampling purposes was low SES (by its inclusion in SSU 2); after updating, it was the highest SES sample school in the PSU.

Table 6-1 shows the sampling interval that would be used for completing the student frame in the sample school. Generally, student listing forms (SLFs) were completed for all students and the sampling interval was one. In some very large schools (e.g., school 61), SLFs were completed for a systematic random sample of age eligibles; this information was also needed to avoid making an impossible sample allocation. The next column shows the number of SLFs expected from the school, computed by dividing the updated age enrollment estimate by the sampling interval.

The conditional probability of selection for each sample school, given that the SSU was previously selected P(School|SSU), was assigned prior to school selection (chapter 5) and was used in conjunction with the conditional SSU probabilities to derive PSU-level expanded enrollments. The purpose in computing the PSU expanded enrollments was not to estimate the PSU enrollment, but rather to guide sample allocations to schools. The PSU-level expanded enrollment for each school was computed by dividing the updated 17-year-old enrollment estimate by the product of the school probability and the appropriate SSU probability. For example, the expanded enrollment equalled 625 [75 ÷ (0.800 x 0.150)] for school 64 and 8,978 for the PSU.

The procedure for oversampling low SES, ultimately achieved at the sample allocation stage for PSU's in SOC strata 1 and 2, is illustrated in Table 6-1. The allocation of 20 total group administrations was determined initially by computing an overall or average allocation rate, R, as 20 divided by the total PSU expanded enrollment:

$$R = \frac{20}{8{,}978} = 0.0022277$$

Table 6-1. Allocation of Group Packages to Schools in a SOC 2 Two-Week PSU, 17-Year-Old Sample*

SSU No.	School number	Updated SES index	Updated estimate of 17-year-olds	SEE sampling interval	Students available for sample	P(School SSU)	PSU-level expanded enrollment	Group packages allocated: Initial	Group packages allocated: Adjusted	Approximate package weight
2	64	54.5	75	1	75	0.80000	625	2.140	2	1.392
2	62	48.3	115	1	115	1.00000	767	2.626	3	1.149
2	65	45.8	197	1	197	1.00000	1,313	4.495	5	1.170
1	63	30.4	158	1	158	0.25700	2,509	4.295	4	2.795
1	61	21.2	436	2	218	0.56000	3,178	5.443	5	2.832
2	66	18.6	39	1	39	0.44318	586	1.004	1	2.614
Totals							8,978	20.000	20	

* Note: P(PSU) = 0.18704, P(SSU-1|PSU) = 0.245, P(SSU-2|PSU) = 0.150

Next, the proportion, λ, of the total expanded enrollment to be sampled at the higher rate (oversampled) was computed by dividing the expanded enrollment of the low SES stratum by the total expanded enrollment. The proportion should be approximately one-third; in this case, it was 0.30129 [(625 + 767 + 1,313) ÷ 8,978].

Sampling the low SES students at approximately twice the rate used for other students was achieved by computing the allocation rates R_1 and R_2 for the low and high SES schools, respectively:

$$R_1 = \frac{2R}{1+\lambda} \quad \text{and} \quad R_2 = \frac{R}{1+\lambda} \qquad (6.3)$$

It can be verified that R_1 is twice R_2 and that their weighted average (weighted by λ and 1 − λ) is R. Values of 0.0034238 and 0.0017119 for R_1 and R_2, respectively, were computed for the example in Table 6-1.

Initial allocations of group packages to schools were computed by multiplying the PSU-level expanded enrollments by the appropriate allocation rate, R_1 or R_2. The initial allocations were rounded off and then adjusted when necessary to avoid exceeding the number of eligible students for each school. Also, the number of group packages allocated to a single school was reduced if it exceeded one-half of the total number of distinct group packages for the age group (e.g., 10 packages for 17-year-olds).

The approximate group package weight was used as a check on the entire procedure. This factor is the weight anticipated to be applied to a single response to a group package exercise; it can also be considered the inverse of the probability of selection of a particular student for a particular group package sample. Since there were 10 distinct group packages for 17-year-olds and since each group session consisted of 12 students, the trial expansion factor or weight, w, was computed as,

$$w = \frac{10 \cdot S_{17}}{12 \cdot G \cdot P(PSU)\,P(SSU \mid PSU)\,P(School \mid SSU)} \qquad (6.4)$$

where

S_{17} = updated estimate of 17-year-old enrollment,

G = number of group sessions allocated to the school.

and the probabilities and conditional probabilities of the PSU, SSU, and school are denoted by P(PSU), P(SSU,PSU), and P(School|SSU), respectively. The weights in high SES schools should be approximately twice the weights in the low SES schools, due to low SES oversampling (Table 6-1).

The oversampling procedure discussed in this section was not used with SOC 3 and 4 PSU's, since the low SES PSUs of these SOC strata were oversampled at the PSU selection stage. Instead, a single sampling rate (R) was calculated and applied to the expanded enrollment for each sample school. The approximate group package weights were, thus, about equal for all sample schools within each SOC 3 or 4 PSU.

Specific Package Assignments

Within a PSU, the procedure used to allocate the PSU's total group package administrations to sample schools was discussed in the previous section. The specific group packages to be administered in each sample school were assigned using a random permutation method. First, a random permutation of the distinct group package numbers was generated independently for each PSU. The sample schools were ordered by SES, and the group packages were assigned to schools in the permuted order. Table 6-2 shows the number of group packages assigned to each school in the two-week PSU of Table 6-1. The random permutation for the PSU is shown, and the method used to assign the permuted group package numbers to the schools is apparent. School 64 was assigned two group sessions and was first on the list: therefore, it was assigned packages 1 and 8. School 62, assigned three group sessions, was listed next and was assigned packages 3, 4, and 5, the next three numbers in the permutation.

The sample for each individual package was allocated to schools by associating individual package administrations with group package administrations. For 9-year-olds, as an example, a school assigned group packages 2, 3, and 8 was also assigned three sessions of package 10, four sessions of package 11, and four sessions of package 12. Table 6-2 shows the number of individual packages 11 and 12 assigned to each sample school, based on the association rules for 17-year-olds shown in Table 6-3. The method used to assign individual package sessions to schools spreads the sample for each individual package across most of the sample schools.

Table 6-2. Assignment of Specific Group and Individual Packages to Schools in a Hypothetical Two-Week PSU, 17-Year-Old Sample

School No.	SES index	No. of group sessions	Group package numbers*					Individual packages Number 11	Individual packages Number 12
64	54.5	2	1	8				2	2
62	48.3	3	3	4	5			3	3
65	45.8	5	6	10	7	9	2	5	5
63	30.4	4	1	8	3	4		4	4
61	21.2	5	5	6	10	7	9	5	5
66	18.6	1	2					1	1

*Random permutation 1 8 3 4 5 6 10 7 9 2

Table 6-3. Number of Individual Packages Associated With Each Group Package, by Age Group

Age group	Individual package number	Group package number 1	2	3	4	5	6	7	8	9	10	11	12	13
9-year-olds	10	2	1	1	1	1	1	1	1	1	--	--	--	--
	11	1	2	1	1	1	1	1	1	1	--	--	--	--
	12	1	1	2	1	1	1	1	1	1	--	--	--	--
13-year-olds	14	0	0	0	1	1	1	1	1	1	1	1	1	1
	15	1	1	1	1	1	1	1	1	1	1	--	--	--
17-year-olds	11	1	1	1	1	1	1	1	1	1	1	--	--	--
	12	1	1	1	1	1	1	1	1	1	1	--	--	--

Supplemental Package Assignments

Schools with too few students in an age group to schedule a full group session and associated individual sessions were assigned supplemental packages. These schools were usually the same ones

Table 6-4. Allocation of Group Packages to Schools in a Two-Week PSU — 9-Year-Old Sample

SSU No.	School number	Updated SES index	Updated estimate of 9-year-olds	SSU sampling interval	Students available for sample	P(School SSU)	PSU-level expanded enrollment	Group packages allocated: Initial	Group packages allocated: Adjusted	Approximate package weight
2	08	54.8	38	1	38	82058	291	1.025	1	1,230
2	10	51.7	54	1	54	84848	304	1.388	1	1,668
2	09	49.2	57	1	57	54286	418	1.473	2	883
1	13	48.3	73	1	73	64602	491	1.730	2	1,038
2	05	47.7	57	1	57	69512	327	1.152	1	1,382
2	06	47.6	23	1	23**	95800	96	--	--	--
1	03	47.1	48	1	48	48080	426	1.501	2	900
1	01	46.6	23	1	23**	54762	183	--	--	--
2	11	46.0	59	1	59	50862	462	1.628	2	976
1	02	44.6	33	1	33	36700	301	1.378	1	1,652
2	12	43.5	71	1	71	59664	474	1.670	2	1,002
1	04	42.5	109	1	109	75695	626	2.205	2	1,323
1	07	41.2	61	1	61	32796	809	2.850	2	1,710
2	14	17.5	11	1	11**	10000	438	--	--	--
		Total PSU-level expanded enrolled					5,826	18.000	18	
		Total, less the supplemental session schools					5,109			

*P(PSU) = 0.17744, P(SSU-1|PSU) = 0.230, P(SSU-2|PSU) = 0.281

** Inadequate number of students for conduct of group session and associated individual sessions

identified as supplemental package schools at the school selection stage, but if early enrollment estimates were inaccurate, this classification was changed before student [illegible] allocations and package assignments. The only unalterable [illegible] associated with each school was its probability of selection.

[illegible] illustrates the [illegible] sample [illegible] calculations for small schools. Schools 06, 01, and 14 [illegible] 9-year-old enrollments. At least 23 students were required to schedule a group session (12 for the group session with four alternates and three or four individual sessions with three or four alternates) [illegible] shown in Table 6-3. An ordered pair of supplemental [illegible] was randomly selected for each PSU to be used as needed [illegible] in Table 6-4, packages 9 and 12 were randomly selected. Supplemental packages were generally allocated in units of 3, 6, 9, or 12 students (for group packages) to avoid assessing fewer than three students at any school, but the numbers were limited to 10 per PSU for individual packages and 12 for group packages.

Figure 6-[illegible] illustrates the allocation of the supplemental package sample [illegible] the PSU in Table 6-4. Only one [illegible] mental package number [illegible] assigned to any school. The first [illegible] the random pair was assigned first from the top of the [illegible], and the second package was assigned last. The schools were ordered by SES, [illegible] package allocation [illegible]. The PSU-level expanded enrollment was the guide for the approximately proportional allocation. The computed trial expansion factors (or weights) was a check on the allocation procedure [illegible] this factor is approximately the reciprocal of the stage [illegible] overall planned selection probability.

Table 6-5. Allocation of Supplemental Packages to Small Schools [illegible] Four-Week PSU 9-Year-Old Sample*

School No.	Updated SES index	Estimated 9-year-olds updated	PSU-level expanded enrollment	Sample allocation** Package number	Sample allocation** Sample size	Approximate package weight
06	[illegible]	23	[illegible]	9	[illegible]	2.164
01	[illegible]	[illegible]	[illegible]	[illegible]	9	1.378
14	[illegible]	11	[illegible]	[illegible]	10	2.962

* P(PSU) = [illegible]

** Packages 9 and 11 were randomly selected for supplemental sample

Selection of Sample Students

A sample of students was selected from each school by field personnel using special instructions prepared individually for each school. First, the sampling frame of age-eligible students within each sample school was constructed. Second, the students allocated to each school were selected using a systematic random sampling procedure.

The Student Sampling Frame

The student sampling frame for each school was constructed by completing a student listing form (SLF) for each age-eligible student enrolled. The DS handed out SLFs (Figure 6-2) to each school principal at the preassessment meeting. The SLFs were completed for each age-eligible student, regardless of grade, shortly before the assessment period. The SLFs could be completed from school records, by homeroom teachers, by the students, or by any other convenient method. Schools with very large enrollments were offered the option of completing SLFs for a systematic random sample of all age-eligible students; these cases were anticipated on the basis of advance estimates of enrollment. The SLFs, used for sample

STUDENT LISTING FORM (13)

COMPLETE FOR STUDENTS BORN DURING CALENDAR YEAR OF 1957.

1. Name Miller John David
(Last) (First) (Middle)

2. Room or Section 8-B

3. Grade 8 4. Sex M 5. Birth date 3/57
Mo. / Year

PLEASE DO NOT WRITE BELOW THE DOUBLE LINE

6. Selected for sample ______ 7. 152 253 348

Alternate number ______

Identification |_|_| |_|_|_|_|_|
Package No. Student I.D. No.

Figure 6-2. Example of a completed Student Listing Form

selections, were never removed from the school and the students' names did not appear on the assessment packages so the confidentiality of students' responses was protected.

Selecting the Sample Students

Sample and alternate students were selected with equal probabilities and without replacement from the school SLF frame of eligible students. The district supervisor (DS), following strict sampling instructions from the Central Office, used a systematic random sampling procedure while holding the deck of SLFs face down to avoid a possible selection bias.

The DS would first cut the SLF deck 10 times to establish a random starting point. Then, using the sampling intervals supplied by the Central Office, he would systematically select 2 I_i SLFs for the individual packages and 16 G_i SLFs for the group packages assigned to the school where

I_i number of individual sessions assigned school-i, and
G_i number of group sessions assigned school-i.

The 2 I_i selected SLFs would next be dealt into stacks, one for each individual package, with one sample SLF and one alternate SLF identified systematically for each of the I_i sessions. Finally, the 16 G_i selected SLFs would be dealt into G_i stacks, with 12 sample SLFs and 4 alternate SLFs identified systematically for each of the G_i sessions.

In the next chapter, the response rates experienced in year 02 are discussed.

CHAPTER 7

YEAR 02 IN-SCHOOL RESPONSE EXPERIENCE

General

Probability sampling enables researchers to draw inferences about entire populations based on data collected from samples of these populations. The technique requires strict adherence to sampling principles in the selection of the sample and in the identification of sampling units at all stages of sample selection. In addition, strict application of the theory requires that all observations be completed on the selected sampling units. For surveys of human populations, this means that all sampled individuals must cooperate by providing the requested data. Since cooperation in most surveys is voluntary, complete cooperation is almost never achieved.

Noncooperation, or nonresponse, can bias the estimates derived from the sample data if the measured characteristics of the respondents differ from those of the nonrespondents. Nonresponse reduces the sample size and thus reduces precision of sample estimates. Reduction in precision may be avoided by selecting alternate sampling units, but any existing biases may remain.

Every effort was made to remain as close to the ideal 100% cooperation as possible in the National Assessment in-school survey. The response achieved at the several stages of sampling is discussed in this chapter.

Primary Sample Response

A total of 116 primary sampling units (PSU's) were selected for the school sample. Of these, 16 were one-week PSU's and 100 were two-week PSU's. Each of the 50 states had at least one PSU selected from within its boundaries. Complete state cooperation was achieved in year 02.

Cooperation problems with school systems that were serious enough to cause nonresponse of an entire PSU sample occurred in two cases. Both were two-week PSU's. After efforts to gain voluntary cooperation were exhausted, replacement PSU's were selected from the same major strata and state strata cells (discussed in chapter 4).

In a third two-week PSU, noncooperation in one of the two school districts reduced the within-PSU sample by about one-half. In this case, an alternate PSU was selected within the same major stratum, and a sample of schools and students corresponding to a one-week PSU was selected as a replacement.

School Response

A total of 3,271 schools was selected for all three age groups within the sample and replacement PSU's. Of these, 92 had closed and 274 had no eligible students in the appropriate age groups. Neither the closed schools nor those without eligibles affected the integrity of the data; both cases were looked upon as contributing zeros to the numerators and denominators of the ratio estimates constructed from the data.

Noncooperation, or refusals to participate, occurred in 238 schools, about 7.3% of the total school sample. The 238 refusals include those in the three two-week PSU's discussed in the previous section even though they could be better associated with school district refusals.

In most PSU's, school refusals were not replaced by alternate selections. Rather, the sample size was maintained by allocating the entire planned, within-PSU student sample among the cooperating schools. In four PSU's, school refusals reduced the sample so much that the remaining schools could not be assigned all packages, so alternate schools were selected as replacements. The school weights were adjusted as necessary to give the PSU proper representation in the total sample. In all but 5 of the 238 refusals, the reallocation of the student sample was achieved in the usual package assignment system by using the adjusted school weights since the refusals occurred before package assignment.

Tables 7-1 and 7-2 summarize the school response experience by age group at two points in time after the preassessment meetings

Table 7-1. School Response After Preassessment Meetings, by Age Group

Response experience	9-year-olds		13-year-olds		17-year-olds	
	No. of schools	%	No. of schools	%	No. of schools	%
Cooperating:						
No eligibles	32	2.7	135	10.3	78	9.8
Closed	42	3.6	34	2.6	16	2.0
Participating	1,014	86.9	1,051	80.2	636	80.1
Total	1,088	93.2	1,220	93.1	730	91.9
Refused	79	6.8	90	6.9	64	8.1
Total	1,167	100.0	1,310	100.0	794	100.0

Table 7-2. School Response After the Assessment, by Age Group

Response experience	9-year-olds No. of schools		13-year-olds No. of schools		17-year-olds No. of schools	
Cooperated						
No eligibles	36	3.1	157	12.0	81	10.2
Closed	42	3.6	34	2.6	16	2.0
Assessed	1,007	86.3	1,029	78.5	631	79.5
Total	1,085	93.0	1,220	93.1	728	91.7
Refused	82	7.0	90	6.9	66	8.3
Total	1,167	100.0	1,310	100.0	794	100.0

and after the assessment. All school closings were noted before the assessment, usually in conversations with the school district superintendents. Schools without eligibles were usually noted at the preassessment meeting conducted by the district supervisor. The 29 small schools identified as having no eligibles after package assignment illustrated the need for supplemental package assignments (chapter 6).

Student Response

Table 7-3 summarizes, for the three age groups, the student responses in terms of planned sample sizes, administration sessions completed, and number of respondents. Schools assigned regular packages represent the planned sample and the actual responses in all schools except those assigned supplemental packages. No planned sample sizes are shown for the supplemental package assignment system, a purposefully flexible approach used to give all students a positive probability of selection without guaranteeing any minimum sample size from the low-enrollment schools.

The overall response for the three age groups was 94.1% of the total planned sample for group packages and 99.3% for individual packages. The 9-year-olds and 13-year-olds show similar responses for both group and individual packages. The 17-year-old response was considerably lower on the group packages, possibly reflecting more absenteeism (or other scheduling problems) or that some students officially enrolled were, in fact, dropouts or attend so irregularly that their classification as enrolled would be questionable. The samples

Table 7-3. Within-School Responses by Age Groups

Item	Regular package assignments: Number planned	Regular package assignments: Number completed	Regular package assignments: Percent completed	Supplemental assignments completed	Total assignments completed
9-year-olds					
Group sessions	1,944	1,936	99.6	98	2,034
Group sample sizes	23,328	22,394	96.0	826	23,220
Individual sessions	6,480	6,439	99.4	173	6,612
13-year-olds					
Group sessions	2,808	2,807	100.0	167	2,974
Group sample sizes	33,696	32,316	95.9	886	33,202
Individual sessions	4,320	4,309	99.7	87	4,396
17-year-olds					
Group sessions	2,160	2,150	99.5	43	2,193
Group sample sizes	25,920	23,350	90.1	377	23,727
Individual sessions	4,320	4,272	98.9	47	4,319

were selected from the currently enrolled students as shown by school records.

The higher percentages for individual than for group packages completed (Table 7-3) can probably be attributed to the policies for selecting alternates used in conducting the sessions. For each group session, four alternates were selected and used as needed to maintain a total of 12, when possible. Generally, the group session was rescheduled if fewer than eight students were available. For individual package sessions, one alternate was designated for each session so that an administration could be completed even if a selected student was absent on the scheduled day. This resulted in higher use of alternates for individual packages, as shown in Table 7-4. This table also compares the percentages of students assessed as originally selected and the alternates. More alternates were assessed for 17-year-olds than for 9-year-olds or 13-year-olds.

Methods used to compute National Assessment p-values (the estimated proportion of the population who would answer a given exercise correctly) are discussed in the next chapter.

Table 7-4. Use of Alternates by Age Groups, by Package Type

Students assessed	Group packages		Individual packages	
	Students	Percent	Students	Percent
9-year-olds				
Original selections	21,151	91.1	5,950	90.0
Alternate selections	2,069	8.9	662	10.0
Total	23,220	100.0	6,612	100.0
13-year-olds				
Original selections	29,733	89.6	3,869	88.0
Alternate selections	3,469	10.4	527	12.0
Total	33,202	100.0	4,396	100.0
17-year-olds				
Original selections	19,496	82.2	3,285	76.1
Alternate selections	4,231	17.8	1,034	23.9
Total	23,727	100.0	4,319	100.0

CHAPTER 8

ESTIMATION PROCEDURES, SCHOOL SAMPLE

Introduction

National Assessment estimates of the performances of populations and subpopulations on specific exercises are based on the responses of persons in the probability sample of a particular population or subpopulation. The population parameter, P, for an exercise is defined as,

$$P = \frac{Y}{X}, \tag{8.1}$$

where X, the denominator, represents the total number of subpopulation members and Y, the numerator, denotes the number of those who would answer the exercise correctly.

In year 02, the procedure used was to estimate Y and X by $\hat{Y}$ and $\hat{X}$, respectively, and then to estimate P by $\hat{P}$:

$$\hat{P} = \frac{\hat{Y}}{\hat{X}} \tag{8.2}$$

This estimator applied to a stratified sample is called a combined ratio estimator. If other biases, such as those due to nonresponse, are ignored, unbiased estimates of Y and X can be obtained. The combined ratio estimate, $\hat{P}$ for P, is biased[1] due to the covariance between $\hat{P}$ and $\hat{X}$; in most relatively large samples drawn from very large populations, this covariance is negligible.

Estimation at the Primary Sampling Stage

To discuss the relation of the PSU selection probabilities, $P(u_{ijk})$, to the estimation procedure without discussing probabilities of selections related to later stages of the sample selection, two constants or parameters associated with each PSU, u_{ijk}, must be defined. For the combined ratio, P, described above, the parameter X_{ijk} is defined as the number of subpopulation members in PSU-ijk and Y_{ijk} as the number of those who would answer the exercise correctly. The population parameters, X and Y, may be expressed in terms of X_{ijk} and Y_{ijk}:

$$X = \sum_{i=1}^{R} \sum_{j=1}^{C} \sum_{k=1}^{N_{ij}} X_{ijk} \quad \text{and} \quad Y = \sum_{i=1}^{R} \sum_{j=1}^{C} \sum_{k=1}^{N_{ij}} Y_{ijk} \qquad (8.3)$$

where the summation is over R major strata, C state strata, and N_{ij} PSU's within each cell. These expressions are valid even if N_{ij} is zero for some cells.

If the X_{ijk} and Y_{ijk} were observed on the basis of all eligible respondents in each sample PSU, unbiased estimates of X and Y could have been constructed using the Horvitz-Thompson estimator:

$$\hat{X}_s = \sum_{i} \sum_{j} \sum_{k} \frac{X_{ijk}}{\Pr(u_{ijk})} \quad \text{and} \quad \hat{Y}_s = \sum_{i} \sum_{j} \sum_{k} \frac{Y_{ijk}}{\Pr(u_{ijk})} \qquad (8.4)$$
$$(i,j,k) \in S$$

where $\Pr(u_{ijk})$ is the probability that PSU-ijk will be selected (equation 1.3, chapter 1), and the summation is over elements in the sample, S.

Since only a small sample of all eligible respondents in each PSU participated, it was necessary to estimate X_{ijk} and Y_{ijk} within each sample PSU. Details of this estimation procedure are discussed next.

Estimation of PSU Totals

For simplicity of notation, the 116 sample PSU's are denoted in this section by i = 1, 2, . . . , 116. For each PSU, estimates of X_i and Y_i were needed in order to compute:

$$\hat{P} = \frac{\hat{Y}}{\hat{X}} = \frac{\sum_{i=1}^{116} \frac{\hat{Y}_i}{\Pr(u_i)}}{\sum_{i=1}^{116} \frac{\hat{X}_i}{\Pr(u_i)}} \qquad (8.5)$$

The X_i and Y_i were estimated by:

$$\hat{X}_i = \sum_{j,k,l} \frac{X_{ijkl}}{\Pr(u_{ij} \mid u_i) \cdot \Pr(u_{ijk} \mid u_{ij}) \cdot \Pr(u_{ijkl} \mid u_{ijk}) \cdot \Pr(\ldots \mid u_{ijkl})}$$

and (8.6)

$$\hat{Y}_i = \sum_{j,k,l} \frac{Y_{ijkl}}{P(u_{ij} \mid u_i) \cdot P(u_{ijk} \mid u_{ij}) \cdot P(u_{ijkl} \mid u_{ijk}) \cdot P(\alpha \mid u_{ijkl})}$$

where

X_{ijkl} = 1 if the l-th student in the ijk-th school belongs to the subpopulation, or 0 otherwise;

Y_{ijkl} = 1 if X_{ijkl} is 1 and the ijk$l$-th student correctly answered the particular exercise, or 0 otherwise;

$P(u_i)$ = the probability of selection for the i-th PSU (chapter 4);

$P(u_{ij} \mid u_i)$ = the probability of selection for the ij-th SSU in the i-th PSU given that the i-th PSU was selected (chapter 5);

$P(u_{ijk} \mid u_{ij})$ = the probability of selection for the k-th school in ij-th SSU given that the ij-th SSU was selected (chapter 5);

$P(u_{ijkl} \mid u_{ijk})$ = the probability of selection for the l-th student in ijk-th school given that the school was selected; and

$P(\alpha \mid u_{ijkl})$ = the probability that the ijk$l$-th student is assigned α, the package containing the exercise.

Except for schools in the supplemental package sample, the probability of selection of the ijk$l$-th student, given that the ijk-th school was selected, depended on the number of group sessions, G_{ijk}, assigned to the school and on the total number of age group enrollees, R_{ijk}:

$$P(u_{ijkl} \mid u_{ijk}) = \frac{G_{ijk} \cdot E(n_g)}{R_{ijk}} \qquad (8.7)$$

where $E(n_g)$ was the expected, or average, number of sample students required for a group session and its associated individual package sessions. In year 02, for the 9-year-olds, 13-year-olds, and 17-year-olds, the values of $E(n_g)$ were, respectively, 15-1/3, 13-7/13, and 14. The number of sample students required for each group package assigned to a sample school is shown in Table 6-3 (chapter 6). For 9-year-olds, 16 sample students were required for each assignment of group packages 1, 2, or 3 and 15 for each assignment

of packages 1, 5, 6, 7, 8, or 9. Thus, the average number required per group package assigned was

$$E(n_g) = (1/3)(16) + (2/3)(15) = 15\text{-}1/3.$$

The probability of assigning a particular package to a sample student depended on the number of group and individual packages and on the sample size associated with each package. Since packages were assigned to students by a sampling process which was independent of the student selection process, the conditional probability of assigning a particular package to the selected ijk*l*-th student depended only on the package number, α. Therefore, for a particular age group, $P(\alpha | u_{ijkl})$ can be written more simply as $P(\alpha)$:

$$P(\alpha) = \frac{12}{12G + 10I} \text{ for group packages,}$$

and (8.8)

$$P(\alpha) = \frac{10}{12G + 10I} \text{ for individual packages;}$$

where G is the number of distinct group packages and I is the number of distinct individual packages for the age group survey.

In schools selected for the supplemental package sample, the student probability, given the school was selected, depended on the number of sample students, n_{ijk}, allocated to the school and on the total age group enrollment, R_{ijk}:

$$P(u_{ijkl} | u_{ijk}) = \frac{n_{ijk}}{R_{ijk}} \qquad (8.9)$$

In any case, n_{ijk} in practice was bounded by R_{ijk}. The probability of assigning a particular package to a selected student was simply:

$$P(\alpha) = \frac{1}{I + G} \qquad (8.10)$$

for the supplemental packages.

Adjustments for Nonresponse

The procedures described so far assume a complete response at all stages of the sampling design. Approximately 7.3% of the selected

schools refused to participate (chapter 7). In a few PSUs, the cooperation problems were so severe that replacement PSUs were selected. The data were adjusted for refusals by recomputing the PSU and school selection probabilities for cooperating schools in the same strata and by assuming that only the cooperating schools had been selected initially.

In some cases, fewer than the planned number of students participated in package sessions within a school. The factor, $f_{ijk\alpha}$, was computed to correct for the nonresponse to package-α within school-ijk; thus,

$$f_{ijk\alpha} = \frac{n_{ijk\alpha}}{n'_{ijk\alpha}} \tag{8.11}$$

where

$n_{ijk\alpha}$ = planned sample size for package-α in school-k of SSU-j of PSU-i;

$n'_{ijk\alpha}$ = actual sample size for package-α in school-k of SSU-j of PSU-i

The final equations used to compute $\hat{X}_i$ and $\hat{Y}_i$ (equation 8.6) with corrections for nonresponse were as follows:

$$\hat{X}_i = \sum_{j,k,l} \frac{X_{ijkl}/f_{ijk\alpha}}{P(u_{ij}|u_i)\cdot P(u_{ijk}|u_{ij})\cdot P(u_{ijkl}|u_{ijk})\cdot P(\alpha|u_{ijkl})}$$

and (8.12)

$$\hat{Y}_i = \sum_{j,k,l} \frac{Y_{ijkl}/f_{ijk\alpha}}{P(u_{ij}|u_i)\cdot P(u_{ijk}|u_{ij})\cdot P(u_{ijkl}|u_{ijk})\cdot P(\alpha|u_{ijkl})}$$

Survey Weights

Equation 8.5 may also be written with weights, $W_{ijkl\alpha}$, as:

$$\hat{p} = \frac{\hat{Y}}{\hat{X}} = \frac{\sum_i \sum_j \sum_k \sum_l W_{ijkl\alpha} Y_{ijkl}}{\sum_i \sum_j \sum_k \sum_l W_{ijkl\alpha} X_{ijkl}} \tag{8.13}$$

where

$$W_{ijk\ell\alpha} = \frac{f_{ijk\alpha}}{P(u_i)\,P(u_{ij} \mid u_i)\,P(u_{ijk} \mid u_{ij})\,P(u_{ijk\ell} \mid u_{ijk})\,P(\alpha \mid u_{ijk\ell})}.$$

In this form, the $W_{ijk\ell\alpha}$ values are the survey weights, or expansion factors, applied to the package-α survey responses. These weights depend on the selection probabilities for all stages of the design, on the nonresponse adjustments, and on the estimation method.

WORKS CITED IN CHAPTER 8

1. M. G. Kendall and A. Stuart. *The Advanced Theory of Statistics*. Vol. III. London: Charles Griffin and Company Limited, 1966.
2. D. G. Horvitz and D. J. Thompson. "A Generalization of Sampling Without Replacement from the Finite Universe," *Journal of the American Statistical Association*. Vol. 47, 1952.

CHAPTER 9

GENERAL DESCRIPTION, HOUSEHOLD SAMPLE

Introduction

This chapter and the next four chapters describe the year 02 household sample design. Chapter 9 gives a general description of the household design. Chapter 10 describes the selection of the primary sampling units (PSU's). Chapter 11 describes the selection of secondary sampling units or land area segments, the procedures used to identify eligible respondents associated with secondary units, and the method used to assign assessment packages to respondents. The response experience for the year 02 assessment is briefly summarized in chapter 12. The basic method used to estimate National Assessment p-values (proportion answering an exercise correctly) is discussed in chapter 13.

Target Populations

The household sample was aimed at three age groups: 17-year-olds not enrolled in school, young adults 26 to 35 years of age, and 18-year-olds who were not enrolled in school when they were 17 years old. Even though these 18-year-olds were not one of the original target populations, it was assumed that they would perform essentially the same way on National Assessment exercises as the out-of-school 17-year-olds. Therefore, both 17-year-olds and 18-year-olds are referred to as 17-year-olds for the out-of-school survey. Seventeen-year-olds enrolled in school during March and April of 1971 were identified and assessed through the school sample.

No other means of sampling was used for the young adult population. In the area sample, young adults and out-of-school 17-year-olds living in group quarters rather than households were not included in the sample.

The field operation for year 02 of National Assessment was scheduled so that the young adults and out-of-school 17-year-olds were assessed beginning in March 1971 and ending in July 1971. Table 9-1 shows the survey period and the eligible birth dates for the target populations. The survey period for out-of-school 17-year-olds coincides approximately with that of the in-school 17-year-olds (Table 3-1); the eligible birth dates for out-of-school 17-year-olds are identical to those for 17-year-olds in the school sample, and the eligible birth dates for 18-year-olds are one year earlier than those for

17-year-olds. The mid-range age and the extreme ages allowed by the eligibility criteria for each age group are presented in Table 9-2.

Table 9-1. Definitions of Out-of-School Populations for the Household Sample, Year 02 (Survey Period: March to July 1971)

Age group	Period not enrolled in school	Eligible birth dates
Adults, ages 26 to 35	--	4-1-35 to 3-31-45
17-year-olds	1-1-71 to 1-31-71	10-1-53 to 9-30-54
18-year-olds	3-1-70 to 3-31-70	10-1-52 to 9-30-53

Table 9-2. Age Range for Eligibles in Household Sample, Year 02

Age Group	Eligible age range		
	Minimum	Mid-range	Maximum
Adults, 26 to 35	25 yrs. 11 mos.	31 yrs. 1-1/2 mos.	36 yrs. 4 mos.
17-year-olds*	16 yrs. 5 mos.	17 yrs. 1-1/2 mos.	17 yrs. 10 mos.
18-year-olds**	17 yrs. 5 mos.	18 yrs. 1-1/2 mos.	18 yrs. 10 mos.

* Not enrolled in school when 16 years 3 months to 17 years 4 months of age.

** Not enrolled in school when 16 years 5 months to 17 years 6 months of age.

The Multi-Stage Design

The household survey was designed as a multi-stage sample, meaning that the sample was selected in stages. Multi-stage designs concentrate the sample in a few areas, thus reducing field costs.

The primary sampling units (first-stage sampling units) were geographic land areas consisting of one or more counties. The primary sample consisted of 52 PSU's selected with probabilities approximately proportional to a measure of size. The size measures were the preliminary county populations from the 1970 Census.

The secondary sampling units (second-stage sampling units) were land area segments or clusters of housing units within the PSUs. The area segments were divided into five socioeconomic status substrata

within each PSU; two units were selected with equal probabilities from each substratum.

The third-stage sampling units were the occupied housing units within the secondary sampling units, and the fourth-stage sampling units were eligible young adults and out-of-school 17-year-olds within the occupied housing units. There was no subsampling within the secondary units; that is, all eligibles in all occupied housing units of the secondary sampling units were included in the sample.

Unlike the school sample, the household sample had no requirement that all states and the District of Columbia be included in the sample. Consequently, no such restriction was imposed on the sample design.

Because the same primary sample was to be used for several years, PSU's were constructed so that each PSU contained enough age-eligibles for several years of assessment without assessing any respondent more than once. Another reason for establishing a minimum population for PSU's was the requirement for oversampling the low socioeconomic portion of the population. All PSUs had to contain a large enough population to make oversampling feasible within sample PSU's for certain sizes of community strata. These requirements were met when the sampling frame was constructed in 1970. Each PSU in the frame was required to contain at least 20,000 total population; thus, counties with 1970 populations less than this minimum were combined with other counties prior to the primary sample selection.

The year 01 household survey results did not approach the completeness or the quality of the year 01 school survey. The low individual completion rate (the proportion of eligibles in screened housing units who completed one or more assessment packages) and the low household screening rate (the proportion of sample housing units who provided name, age, and sex information of occupants) led to a decision to use a smaller but expandable primary sample in year 02 to test whether modifications in the field procedures would improve the response rates. If a larger year 03 primary sample were required, it would be more economical for it to include the 52 PSU's selected for the year 02 primary sample. Accordingly, 208 PSUs were selected with probabilities proportional to size, and subsequently 52 of the 208 were selected with equal probabilities for the year 02 household primary sample. Additional PSUs could be selected from the 156 remaining PSU's for year 03 or later; thus, the overall probabilities of selection for PSU's in the expanded sample would be proportional to size.

Planned Sample Size

Approximate overall sample size for each package (1,040 for adults and 15.4 for out-of-school 17-year-olds, Table 9-3) for the year 02 household survey is smaller than the 2,000 to 2,500 determined in the year 01 planning for two reasons. A year 01 household screening rate of 77% and an individual completion rate of 57% gave the overall completion rate of approximately 44% (77% times 57%). A year 01 quality check survey indicated that more experienced interviewers, constant supervision, and monetary incentives for eligible young adults were needed to raise the overall completion rate to over 70% (to 91-1 2% for household screening, times 80% for eligibles with incentives).

Table 9-3. Sample Sizes Planned for Age Groups in the Household Survey, Year 02

Age group	Number of packages	Overall sample: Sample size package	Overall sample: Total sample size	PSU sample: Sample size, package	PSU sample: Total sample size
Young adults	6	1,040	6,240	20	120
17-year-olds	12	15.4	185	0.3	3.6

To enhance quality and completeness for year 02, the overall sample size per adult package (1,040) was planned at approximately one-half the full-scale year 01 sample size. Each package was administered to either a young adult or an out-of-school 17-year-old, and each eligible was given the option of completing one, two, three, or four assessment packages. Of the eligible young adults, 70% were expected to average completing 3.5 packages. The number of households in the sample was limited to the number required to produce approximately 1,040 responses for each of the six young adult packages plus 15.4 responses for each of the 12 packages used for 17-year-olds. Based on the results of the year 01 household survey quality check, an incentive of $5.00 a package was offered to the respondents agreeing to complete two or more packages.

Most of the out-of-school 17-year-olds surveyed in year 02 were assessed from three supplemental list frame surveys: about two-thirds, from lists of dropouts provided by a sample of high schools; about a third, from lists of enrollees at Job Corps and Neighborhood Youth Corps sites. Details of the supplemental surveys are covered in a separate report.[1]

Each young adult package was expected to be administered approximately 20 times in each of the 52 PSUs. For the household samples, the planned PSU sample sizes were expected averages rather than fixed numbers, as they were in the school sample.

A National Assessment field supervisor visited the PSU initially to list addresses of all dwelling units located within the physical area and to interview potential field interviewers. The supervisor made other visits periodically to list additional segments, to assist the field interviewers with problems, to conduct quality checks, and to train the field interviewers. Each of the 52 PSUs contained 10 sample segments averaging approximately 16.5 occupied housing units each. Procedures used to select the year 02 sample PSUs and the sample segments are discussed in chapters 10 and 11.

WORKS CITED IN CHAPTER 9

1. R. P. Moore and B. L. Jones. *25U-688-1 Technical Report No. 1. Study of Alternative Sampling Frames for Out of School 17-Year-Olds.* Research Triangle Park, N.C.: Research Triangle Institute, 1971.

CHAPTER 10

THE HOUSEHOLD PRIMARY SAMPLE FOR YEAR 02

Introduction

Guidelines for the year 02 household sample design (chapter 2) required that probability samples of subpopulations (young adults 26 to 35 years of age, and 17-year-olds not enrolled in school) living in households be representative of regional, community size, and socioeconomic status characteristics. A special requirement was a small, but expandable, primary sample.

A method of deep stratification called controlled selection, which utilizes two-dimensional stratification, was used. The method permitted the selection of a probability sample from a two-way grid that satisfied certain restrictions on the marginal sample totals. Use of this method satisfied the original requirements for National Assessment stratification by first allocating the sample to regions and by secondly allocating the sample simultaneously within each region to community characteristics strata, socioeconomic strata, and state strata.

The procedures followed in constructing and stratifying the primary sampling frame are discussed in the next four sections of this chapter. The order of discussion does not follow exactly the steps taken in practice because the two tasks were highly interrelated.

The following chronological list summarizes the set of procedures followed in constructing and stratifying the primary sampling frame.

1. Produce initial list of counties, or similar units, along with required population totals or estimates.
2. Sort the list by regional strata.
3. Sort counties by size of community (SOC) within each region.
4. Combine counties, as needed, to form PSUs which meet certain minimum population sizes.
5. Recalculate size measures and socioeconomic status (SES) indices by PSU.
6. Identify self-representing PSU's and sort into separate strata.
7. Determine SES strata definitions within SOC strata 3 and 4 and sort PSU's by SES within SOC strata.
8. Sort PSU's by state strata within major strata.

Both the selection of the sample of 208 primary sampling units (PSU's) and the selection of a subsample of 52 PSUs for use in year 02 are discussed in the last major section of this chapter.

Constructing the Primary Sampling Frame

Each PSU for the area sample consisted of one or more counties. The sampling frame for selection of the primary sample was a list of PSU's. Every county in the United States was included in exactly one of the PSU's in the list. Special areas, not politically defined as counties, were also included and treated as if they were counties: examples of such areas are election districts in Alaska, parishes in Louisiana, and independent cities in certain states.

The procedures for combining counties into multiple-county units to form PSU's were based on consideration of the desired stratification; the need to have a sufficiently large population in each PSU for the within-PSU sample; the need for oversampling of the low SES population within PSU's in certain SOC strata; and the need for combining counties to obtain practical PSU areas for field operations.

The need for combining two or more counties to form a PSU arises from the necessity of having a sufficiently large population in each PSU to allow the same sample PSU's to be used for several years without sampling any housing units more than once. Approximately 133 housing units, containing some 426 persons, were expected to be in the sample each year in an average PSU. A minimum PSU size of 20,000 was considered large enough to satisfy the minimum population requirement.

Stratification criteria affected the choice of counties that could be combined to form a single PSU. It was considered desirable to combine contiguous counties that were in the same major SOC stratum and in the same state stratum. It was not always possible to meet both the "contiguity" and the "same stratum" criteria in combining counties to form PSU's. If not, the usual procedure was to adhere to the contiguity criterion, to combine counties within the same state but in different SOC strata, and to classify the PSU according to the lowest SOC number of any of its counties. For example, if SOC 2 county was combined with SOC 1 county, the entire PSU consisting of these two counties was classified as a SOC 1 PSU. The strategy of oversampling the low SES population within PSU's in SOC's 1 and 2 meant that a larger pool of eligible respondents would be required in those PSU's. No difficulties in combining counties in different SES strata were encountered because the stratification by SES was done on a PSU basis after all combining of counties to form PSU's had been completed.

Although many PSU's consisted of a single county (or similar unit), most PSU's were of the multiple-county type, particularly in

SOC's 3 and 4. The number of PSU's in the sampling frame was 1,977: this may be contrasted with a total of over 3,000 counties, or similar units, used as the building blocks for constructing the PSU's.

In addition to defining the PSU's in the sampling frame in terms of counties, it was necessary to derive two measures for each PSU. The first was the total PSU population required to determine selection probabilities or expected sample sizes and the second was an SES index to be used for stratification in SOC's 3 and 4.

Preliminary census data on total populations of counties and certain cities were used to classify counties by the four SOC strata and to establish size measures for PSU's. Although the actual data collection was scheduled for the spring of 1971, the most recent census data available were those from the preliminary counts of the 1970 Census. The 1960 Census county tabulations of "percent of families earning less than $3,000 per year" were used as the SES index for counties in SOC's 3 and 4 because no 1970 data on income were yet available.

An example of a sampling frame listing for a major stratum by state stratum cell is shown in table 10-1. The table shows four single county PSU's and four multiple county PSU's within stratum 5739. The 5739 stands for the Northeast region, the low SES portion of SOC 4, and the state of Pennsylvania.

Initial Allocation to Regional Strata

The four regional strata defined at this one level of stratification corresponded exactly to reporting subpopulations: Northeast, Southeast, Central, and West. (The subpopulations were defined in chapter 2.) Figure 1-1 (chapter 1) shows the four regional strata on an outline map of the United States.

Since regions are one of the major reporting categories of National Assessment, a decision was made to allocate the sample equally to them. Table 10-2 shows the sample allocation, the population totals, and estimated measures of size for each. Under optimal allocation assuming equal within-region variances, one would allocate the sample in direct proportion to the regional target populations for estimating national values. Equal rather than proportional allocation to regions was used to provide maximum efficiency for regional comparisons and to provide regional estimates of approximately equal precision. It was estimated that the variance of national estimates would be increased by a factor of about 1%.

Table 10-1. Sampling Frame Within Stratum 5739

PSU number	County code	County name	1970 population	Percent low SES
1	33	Jefferson	43,084	27.0
2	5	Bedford	41,486	30.7
3	30	Greene	35,639	31.0
4	26	Fayette	152,867	32.2
5	31	Huntington	38,289	33.2
	29	Fulton	10,532	36.4
		Total	48,821	33.9
6	55	Snyder	29,323	25.6
	34	Juniata	16,181	32.3
		Total	45,504	28.0
7	57	Sullivan	5,627	28.4
	66	Wyoming	18,386	30.1
		Total	24,013	29.7
8	64	Wayne	28,535	28.1
	52	Pike	11,062	24.1
		Total	39,597	27.0

Table 10-2. Sample Allocation to Regional Strata

Region	1970 Census preliminary population	Percent of total	Sample allocation: 208 PSU sample	Sample allocation: 52 PSU sample
Northeast	53,581,446	26.8	52	13
Southeast	42,874,805	21.4	52	13
Central	55,961,756	27.9	52	13
West	47,852,961	23.9	52	13
U. S. total	200,270,968	100.0	208	52

Stratification Within Regions

The PSU's within each region were stratified by size of community, by socioeconomic status, and by state.

Size of Community (SOC) Strata

Within each regional stratum, the first level of stratification was related to size of community (SOC). At the primary sampling stage, entire counties were classified in one of four SOC categories based on the population of the largest city in the county and whether or not the county was part of a Standard Metropolitan Statistical Area (SMSA). The SOC strata definitions were the same ones used for the in-school primary sample (chapter 4), except that 1970 city populations (rather than the 1960 populations of chapter 4) were used.

Table 10-3 shows the 1970 Census preliminary population totals by SOC strata within the four regions. The preliminary counts were the latest available census data for counties when the primary sampling frame was developed in the fall of 1970. The preliminary counts tend to be slightly smaller than the final counts: the official 1970 U.S. resident population total was 203,235,298—approximately 1.5% higher than the preliminary total.

Table 10-3 shows considerable variation in the relative sizes of the four SOC strata within regions. SOC 1 is the largest, SOC 2 is the smallest. The primary sample was allocated to each SOC stratum in proportion to its size. Proportional allocation was possible because the method used to select the primary sample allowed fractional (rather than integer) PSU allocations.

Within each region, the probability of selection for each PSU was approximately proportional to the size of the PSU, as indicated by the 1970 Census preliminary population count. This probability of selection can more conveniently be considered as an *expected sample size* in repeated sampling. The expected sample size for each PSU was calculated as 52 times the PSU's size measure (1970 population) divided by the sum of the size measures for all PSUs in the region. Some PSU's within SOC 1 were so large that the expected sample size equalled or exceeded one; they were classified as self-representing strata and included in the sample with certainty; the sampling within these PSU's was in proportion to the expected sample sizes. Table 10-4 lists the self-representing PSU's and the expected sample size for each.

Table 10-3. Primary Sample Allocation to SOC Strata

Region and SOC	1970 census preliminary population	Percent of regional population	Expected number of PSUs	Percent of regional allocation
Northeast				
SOC 1	22,249,750	41.5	21,594	41.5
SOC 2	8,445,118	15.8	8,198	15.8
SOC 3	17,222,279	32.1	16,713	32.1
SOC 4	5,664,299	10.6	5,495	10.6
Total	53,581,446	100.0	52,000	100.0
Southeast				
SOC 1	7,625,189	17.8	9,247	17.8
SOC 2	2,881,033	6.7	3,494	6.7
SOC 3	14,361,716	33.5	17,421	33.5
SOC 4	18,006,867	42.0	21,838	42.0
Total	42,874,805	100.0	52,000	100.0
Central				
SOC 1	20,475,286	36.6	19,027	36.6
SOC 2	6,947,877	12.4	6,456	12.4
SOC 3	13,368,887	23.9	12,422	23.9
SOC 4	15,169,706	27.1	14,095	27.1
Total	55,961,756	100.0	52,000	100.0
West				
SOC 1	23,956,061	50.1	26,032	50.1
SOC 2	3,923,293	8.2	4,263	8.2
SOC 3	11,204,546	23.4	12,176	23.4
SOC 4	8,769,061	18.3	9,529	18.3
Total	47,852,961	100.0	52,000	100.0
U. S. totals				
SOC 1	74,306,286	37.1	75,900	36.5
SOC 2	22,197,321	11.1	22,411	10.8
SOC 3	56,157,428	28.0	58,732	28.2
SOC 4	47,609,933	23.8	50,957	24.5
Total	200,270,968	100.0	208,000	100.0

Table 10-4. Self-representing PSU's and Expected Sample Sizes

Region and PSU	1970 population	Expected sample size
Northeast		
Middlesex County, Mass.	1,388,129	1,347
New York City, N.Y.	7,771,730	7,544
Erie County, N.Y.	1,103,413	1,071
Suffolk County, N.Y.	1,107,786	1,075
Nassau County, N.Y.	1,413,012	1,371
Philadelphia County, Pa.	1,927,863	1,871
Allegheny County, Pa.	1,591,270	1,544
Southeast		
Dade County, Fla.	1,259,176	1,527
Central		
Cook County, Ill.	5,427,237	5,043
Wayne County, Mich.	2,642,348	2,455
Cuyahoga County, Ohio	1,701,640	1,581
West		
Maricopa County, Ariz.	963,132	1,047
Los Angeles County, Calif.	6,974,103	7,578
San Diego County, Calif.	1,318,022	1,432
Orange County, Calif.	1,409,335	1,532
Alameda County, Calif.	1,059,051	1,151
Santa Clara County, Calif.	1,057,032	1,149
Dallas County, Texas	1,316,289	1,430
Harris County, Texas	1,722,336	1,872
King County, Wash.	1,142,488	1,241

Socioeconomic Status (SES) Strata

Sampling a greater proportion of the low than of the high socioeconomic status (SES) population—referred to as oversampling—to permit reporting of estimates for subpopulations on the lower extreme of the SES scale was established as an objective in the early planning stages of National Assessment. If the general population could be neatly sorted into two groups, labeled as low SES and high SES, the technical sampling problem for meeting this objective could be easily resolved. The real situation existing in the U.S. population did not allow for this simple resolution.

PSU's, which are usually counties, vary considerably in the proportion of the population which can be classified as low SES, but

every PSU contains some. In planning the year 02 sample, it was decided to attempt to classify the population by SES at one of two stages—at the PSU stage or at the within-PSU stage. The first stage classification, which was useful for relatively small PSUs, was used for SOCs 3 and 4. In SOCs 1 and 2, more data were available so the differences in SES by areas could be used to stratify the population at the second stage—by using 1960 Census data on family income for census tracts and minor civil divisions. The PSUs of SOCs 1 and 2 were more internally heterogeneous, in terms of SES, than those of SOCs 3 and 4; this was a factor in determining the approach to oversampling low SES.

The variable selected to identify low SES at the primary sampling stage was "percent of the population earning less than $3,000."* Table 10-5 shows the range of this variable within each SOC stratum

*County data from the 1960 Census.

Table 10-5. Variation in SES Index for PSUs by SOC Stratum

Region and SOC	Number of PSUs in sampling frame	Percent of families earning less than $3000		
		Minimum	Maximum	Range
Northeast				
SOC 1	15	0.0	22.1	22.1
SOC 2	28	5.5	22.7	17.2
SOC 3	76	6.4	33.3	26.9
SOC 4	99	7.9	43.3	35.4
Southeast				
SOC 1	14	17.2	31.4	14.2
SOC 2	24	5.8	56.7	50.9
SOC 3	137	9.6	55.1	45.5
SOC 4	527	5.0	75.4	70.4
Central				
SOC 1	20	7.2	21.7	14.5
SOC 2	49	5.9	29.9	24.0
SOC 3	121	10.3	41.9	31.6
SOC 4	460	13.5	63.1	49.6
West				
SOC 1	23	10.2	28.4	18.2
SOC 2	30	7.2	43.8	36.6
SOC 3	86	7.7	58.1	50.4
SOC 4	268	7.5	68.8	61.3

of each region. Wide ranges of SES levels in SOC's 3 and 4 indicated that stratification and application of disproportionate sampling rates at the primary sampling level would include more low SES persons in the sample than proportionate sampling would.

In applying disproportionate sampling rates, some increase in variance of the aggregate estimate, for the combined low and high SES subpopulations, was expected. This increase is a function of two factors: (1) the portion of the population sampled at a higher than proportional rate and (2) the relative rate of oversampling. Table 4-6 (chapter 4) shows the joint effects of these two factors on the variance of aggregate estimates. As discussed in chapter 4, the increase in variance may be minimized by keeping the ratio of sampling rates low and by oversampling either a very small portion or a very large portion of the population.

Consideration of the data in Tables 4-6 and 4-7 led to the decisions that, at the primary sampling stage, the low SES strata, being oversampled within SOC 3 and 4, should represent no more than about 20% of the total population within the SOC strata and that the oversampling rate should be less than or equal to 2:1. Table 10-6 shows the final year 02 allocation of the sample to the SES strata within SOCs 3 and 4. The last column in the table shows the ratios of SES-stratum sampling rates to proportional sampling rates; these ratios vary between 1.64 and 1.70 for the low SES and between 0.82 and 0.85 for the high.

Table 10-7 shows how design factors affected the household sample. The portion of the population in each SOC stratum that was oversampled ranged from 0.179 to 0.217. It was possible to control the rate of oversampling at exactly 2:1 in the household survey design since the SES strata received fractional PSU allocations (Table 10-6). In no case was the increase of variances caused by disproportionate allocation to SES strata more than 9%.

State Strata

Stratification by state within regions was not required for the household sample design: there was no special requirement that all states be included in the primary sample. State stratification was used to obtain some of the benefits of stratification. Large-population states were themselves strata. Small states were grouped together until each group contained a total population large enough for the stratum to receive an expected PSU sample size of 2,000 or greater. The tables in the next section indicate which states were grouped within each region. Population size measures and expected sample size allocations for the state strata are discussed in the section which follows.

Table 10-6. Allocation to SES Strata, SOC 3 and 4

Stratum	1970 census population	Sample allocation*	Ratio of SES S.R. to average SOC S.R.**
Northeast			
SOC 3, low SES	3,385,099	5.490	1.67
SOC 3, high SES	13,837,180	11.223	0.84
SOC 4, low SES	1,090,602	1.774	1.68
SOC 4, high SES	4,573,697	3.721	0.84
Southeast			
SOC 3, low SES	2,576,984	5.300	1.70
SOC 3, high SES	11,784,732	12.121	0.85
SOC 4, low SES	3,846,366	7.687	1.65
SOC 4, high SES	14,160,501	14.151	0.82
Central			
SOC 3, low SES	2,900,529	4.429	1.64
SOC 3, high SES	10,468,358	7.993	0.82
SOC 4, low SES	3,026,559	4.688	1.67
SOC 4, high SES	12,143,147	9.407	0.83
West			
SOC 3, low SES	2,322,468	4.180	1.66
SOC 3, high SES	8,882,078	7.996	0.83
SOC 4, low SES	1,742,520	3.160	1.67
SOC 4, high SES	7,026,541	6.369	0.83

* Allocation in this table is the expected number of PSUs allocated to the 208 PSU sample.

** Ratios of the SES stratum within SOC sampling rate to the SOC stratum sampling rate that would result with no oversampling of low SES stratum within SOC stratum. These factors are expressed as R_1/R and R_2/R in Table 3-2.

Table 10-7. Summary of Design Factors Related to Low SES Oversampling

Region and SOC	Proportion of population in low SES stratum	Rate of oversampling (R_1, R_2)	Estimated effect on variances of aggregate estimates
Northeast			
SOC 3	0.197	2.00	1.078
SOC 4	0.193	2.00	1.077
Southeast			
SOC 3	0.179	2.00	1.074
SOC 4	0.214	2.00	1.084
Central			
SOC 3	0.217	2.00	1.085
SOC 4	0.200	2.00	1.079
West			
SOC 3	0.207	2.00	1.083
SOC 4	0.199	2.00	1.080

Summary of Allocation to Within-Region Strata

In chapter 4, eight major strata were formed within each region (see Table 4-9). The same major strata definitions were used for the household sample. Stratum 3, defined as "SOC 2, self-representing," was an empty stratum in all regions in the year 02 household sample. All other strata occurred in all four regions. Table 10-8 shows the number of PSU's in the sampling frame for each major stratum within each region. Tables 10-9 through 10-12 show the total populations in

Table 10-8. Numbers of PSU's in Sampling Frame

Region	Major stratum*							Total
	1	2	4	5	6	7	8	
Northeast	7	8	28	26	50	25	74	218
Southeast	1	13	24	37	100	126	401	702
Central	3	17	49	40	81	111	349	650
West	9	14	30	27	59	62	206	407
United States	20	52	131	130	290	324	1,030	1,977

* Stratum 3 was empty in all regions.

Table 10-9. 1970 Census Populations for the Northeast Region

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Conn., R.I.	--	--	--	79,707	3,830,704	--	--	3,910,411
Del., Md., D.C.	--	1,641,391	2,348,254	236,051	386,215	290,596	261,283	5,163,790
Mass.	1,388,129	721,152	605,413	441,130	2,317,573	--	156,827	5,630,224
N.J.	--	1,522,712	1,867,360	346,997	2,805,803	--	547,125	7,089,997
N.Y.	11,395,941	2,061,292	793,933	665,322	1,757,068	67,268	1,238,878	17,979,702
Pa.	3,519,133	--	2,694,371	1,237,231	2,315,533	431,011	1,472,286	11,669,565
Maine, N.H., Vt.	--	--	135,787	378,661	424,284	301,727	897,298	2,137,757
Total	16,303,203	5,946,547	8,445,118	3,385,099	13,837,180	1,090,602	4,573,697	53,581,446

* Stratum 3 was empty.

Table 10-10. 1970 Census Populations for the Southeast Region

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Va., W.Va.	--	516,405	1,062,005	138,431	1,907,353	42,961	2,578,007	6,245,162
N.C.	--	352,006	53,970	574,750	1,585,159	506,863	1,889,084	4,961,832
S.C.	--	--	--	143,355	1,285,370	126,229	967,927	2,522,881
Ga.	--	594,608	779,021	214,257	694,543	288,105	1,921,504	4,492,038
Fla.	1,259,176	1,513,052	--	170,523	2,617,406	--	1,111,005	6,671,162
Ky.	--	688,774	249,076	89,245	393,863	484,763	1,254,834	3,160,555
Tenn.	--	1,163,266	91,443	254,997	759,217	385,842	1,184,012	3,838,777
Ala.	--	952,115	148,716	480,932	540,483	305,601	945,159	3,373,006
Miss.	--	--	--	282,118	340,781	809,444	726,529	2,158,872
La.	--	585,787	448,529	228,376	945,911	208,796	1,146,911	3,564,310
Ark.	--	--	48,273	--	714,646	687,762	435,529	1,886,210
Total	1,259,176	6,366,013	2,881,033	2,576,984	11,784,732	3,846,366	14,160,501	42,874,805

* Stratum 3 was empty.

Table 10-11. 1970 Census Populations for the Central Region

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Ill.	5,427,237	--	1,990,999	295,854	1,452,427	156,447	1,654,944	10,977,908
Ind.	--	785,085	473,850	770,635	1,769,727	--	1,344,125	5,143,422
Iowa	--	281,478	86,070	234,739	764,587	258,023	1,164,996	2,789,893
Kans.	--	347,939	440,355	173,586	199,598	116,409	944,286	2,222,173
Mich.	2,642,348	849,900	1,817,998	118,776	1,697,533	--	1,651,632	8,778,187
Minn.	--	1,430,440	374,641	163,061	361,852	438,840	999,141	3,767,975
Mo.	--	2,208,861	441,108	492,025	--	1,080,404	410,849	4,633,247
Nebr., N. Dak., S. Dak.	--	387,218	65,430	92,045	551,127	750,092	894,243	2,740,155
Ohio	1,701,640	3,366,872	910,434	421,597	2,157,438	112,977	1,871,072	10,542,030
Wis.	--	1,046,268	346,992	138,211	1,514,069	113,367	1,207,859	4,366,766
Total	9,771,225	10,704,061	6,947,877	2,900,529	10,468,358	3,026,559	12,143,147	55,961,756

* Stratum 3 was empty.

Table 10-12. 1970 Census Populations for the West Region

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Ariz., N. Mex.	963,132	658,733	--	167,828	190,037	99,908	670,741	2,750,379
Calif.	11,817,543	1,340,354	1,714,873	305,898	3,518,283	--	1,018,539	19,715,490
Colo.	--	512,691	727,625	89,086	434,989	--	431,496	2,195,887
Alaska, Hawaii, Idaho, Mont.	--	613,114	--	--	650,773	--	1,159,639	2,423,526
Nev., Utah, Wyo.	--	--	--	--	1,323,827	--	547,288	1,871,115
Okla.	--	908,775	186,560	321,162	88,988	384,682	608,211	2,498,378
Oreg.	--	547,865	318,221	--	541,472	--	648,613	2,056,171
Texas	3,038,625	2,412,741	587,563	1,438,494	989,761	1,257,930	1,264,009	10,989,123
Wash.	1,142,488	--	388,451	--	1,143,948	--	678,005	3,352,892
Total	16,961,788	6,994,273	3,923,293	2,322,468	8,882,078	1,742,520	7,026,541	47,852,961

* Stratum 3 was empty.

a state by major stratum array.

Tables 10-13 through 10-16 summarize the allocations of PSU's to major and to state strata. The cell values in the tables are expected PSU sample sizes in repeated sampling. The allocations in these tables are proportional to the corresponding population values shown in Tables 10-9 through 10-12, except for the oversampled low SESs of

Table 10-13. Primary Sample Allocation Summary for the Northeast Region

State stratum	Expected sample sizes by major stratum* 1	2	4	5	6	7	8	Total
Conn., R.I.	--	--	--	0.129	3.107	--	--	3.236
Del., Md., D.C.	--	1.593	2.279	0.383	0.313	0.473	0.213	5.254
Mass.	1.347	0.700	0.588	0.715	1.880	--	0.127	5.357
N.J.	--	1.478	1.812	0.563	2.276	--	0.445	6.574
N.Y.	11.061	2.000	0.771	1.080	1.425	0.109	1.008	17.454
Pa.	3.415	--	2.616	2.007	1.878	0.701	1.198	11.815
Maine, N.H., Vt.	--	--	0.132	0.613	0.344	0.491	0.730	2.310
Total	15.823	5.771	8.198	5.490	11.223	1.774	3.721	52.000

* Stratum 3 was empty.

Table 10-14. Primary Sample Allocation Summary for the Southeast Region

State stratum	Expected sample sizes by major stratum* 1	2	4	5	6	7	8	Total
Va., W. Va.	--	0.626	1.288	0.285	1.962	0.086	2.578	6.825
N.C.	--	0.427	0.065	1.182	1.631	1.014	1.888	6.207
S.C.	--	--	--	0.295	1.322	0.252	0.967	2.836
Ga.	--	0.721	0.945	0.441	0.714	0.575	1.920	5.316
Fla.	1.527	1.835	--	0.351	2.692		1.110	7.515
Ky.	--	0.835	0.302	0.183	0.405	0.969	1.254	3.948
Tenn.	--	1.411	0.111	0.524	0.781	0.771	1.183	4.781
Ala.	--	1.155	0.180	0.989	0.556	0.611	0.944	4.435
Miss.	--	--	--	0.580	0.350	1.618	0.726	3.274
La.	--	0.710	0.544	0.470	0.973	0.417	1.146	4.260
Ark.	--	--	0.059	--	0.735	1.374	0.435	2.603
Total	1.527	7.720	3.494	5.300	12.121	7.687	14.151	52.000

* Stratum 3 was empty.

SOC's 3 and 4. For example, the expected sample sizes for all entries in columns 1, 2, and 4 of Table 10-15 were obtained by first multiplying the corresponding entries in Table 10-11 by the sample size for the region (52 PSU's) and then dividing the result by the

Table 10-15. Primary Sample Allocation Summary for the Central Region

State stratum	Expected sample sizes by major stratum*							Total
	1	2	4	5	6	7	8	
Ill.	5.043	--	1.850	0.452	1.109	0.242	1.282	9.978
Ind.	--	0.730	0.440	1.177	1.351	--	1.041	4.739
Iowa	--	0.262	0.080	0.358	0.583	0.400	0.903	2.586
Kans.	--	0.323	0.409	0.265	0.152	0.180	0.731	2.060
Mich.	2.455	0.790	1.690	0.181	1.296	--	1.280	7.692
Minn.	--	1.329	0.348	0.250	0.276	0.680	0.774	3.657
Mo.	--	2.053	0.410	0.751	--	1.674	0.318	5.206
Nebr., N. Dak., S. Dak.	--	0.360	0.061	0.141	0.421	1.162	0.693	2.838
Ohio	1.581	3.129	0.846	0.644	1.649	0.175	1.450	9.474
Wis.	--	0.972	0.322	0.210	1.156	0.175	0.935	3.770
Total	9.079	9.948	6.456	4.429	7.993	4.688	9.407	52.000

* Stratum 3 was empty.

Table 10-16. Primary Sample Allocation Summary for the West Region

State stratum	Expected sample sizes by major stratum*							Total
	1	2	4	5	6	7	8	
Ariz., N. Mex.	1.047	0.716	--	0.302	0.171	0.182	0.608	3.026
Calif.	12.842	1.456	1.863	0.550	3.167	--	0.923	20.801
Colo.	--	0.557	0.791	0.161	0.392	--	0.391	2.292
Alaska, Hawaii, Idaho, Mont.	--	0.666	--	--	0.586	--	1.051	2.303
Nev., Utah, Wyo.	--	--	--	--	1.192	--	0.496	1.688
Okla.	--	0.988	0.203	0.578	0.080	0.697	0.551	0.097
Oreg.	--	0.595	0.346	--	0.487	--	0.588	2.016
Texas	3.302	2.622	0.638	2.589	0.891	2.281	1.146	13.469
Wash.	1.241	--	0.422	--	1.030	--	0.615	3.308
Total	18.432	7.600	4.263	4.180	7.996	3.160	6.369	52.000

* Stratum 3 was empty

region's total population (55,961,756). The same computation was made for each entry in columns 5, 6, 7, and 8; then each result was multiplied by the appropriate factors (Table 10-6) for oversampling low SESs (1.643, for stratum 5; 0.822, for 6; 1.667, for 7; and 0.834, for 8). In Tables 10-13 through 10-16, the expected sample sizes for state totals were obtained by row additions of the computed cell values; these tables also indicate which states were combined to form state strata within regions.

It may be easily verified that the total allocation to each SOC stratum agrees with the total in Table 10-3. For example, adding the expected sample sizes of 5.300 and 12.121 for major strata 5 and 6 (Table 10-14) yields 17.421, which is the expected number of PSUs for SOC 3 in the Southeast (Table 10-3).

Primary Sample Selection

From the sampling frame and calculated expected sample sizes (Tables 10-13, 10-14, 10-15, and 10-16), the year 02 primary sample of 52 PSUs was selected in three steps:

1. Setting the sample allocation for each cell using a probability sampling technique called controlled selection,
2. Selecting a probability sample of 208 PSUs from the cells receiving positive allocations, and
3. Selecting a subsample of 52 of the 208 PSUs as the primary sample for year 02 of National Assessment.

Execution of these three steps is illustrated using the Northeast region. Table 10-13 shows the expected sample size for the Northeast, for each major stratum, for each state stratum, and for each major stratum by state stratum cell.

Controlled Selection of Sample Patterns

The controlled selection procedure applied in selecting the 208 sample PSUs insured that the actual sample allocation to any cell, to any major stratum, and to any state stratum differed from the expected values shown in Table 10-13 by less than one PSU. Thus, cells with expected sample sizes greater than or equal to one were assured certain minimum allocations. For the Northeast, Table 10-17 shows 18 cells with minimum allocations greater than zero, for a total of 37 PSUs. The remaining 15 PSUs were allocated using the probabilities shown in the cells of Table 10-18; the marginal values are the expected sample sizes for the major strata and state strata. For major stratum 4, three PSUs were allocated with probability 0.802 and four PSUs with probability 0.198. Thus, the expected

Table 10-17. Minimum Cell Allocations for the Northeast

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Conn., R.I.	--	--	--	0	3	--	--	3
Del., Md., D.C.	--	1	2	0	0	0	0	3
Mass.	1	0	0	0	1	--	0	2
N.J.	--	1	1	0	2	--	0	4
N.Y.	11	2	0	1	1	0	1	16
Pa.	3	--	2	2	1	0	1	9
Maine, N.H., Vt.	--	--	0	0	0	0	0	0
Total	15	4	5	3	8	0	2	37

* Stratum 3 was empty.

Table 10-18. Probabilities of Increasing Minimum Cell Allocations by One PSU, Northeast Region

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Conn., R.I.	--	--	--	0.129	0.107	--	--	0.236
Del., Md., D.C.	--	0.593	0.279	0.383	0.313	0.473	0.213	2.254
Mass.	0.347	0.700	0.588	0.715	0.880	--	0.127	3.357
N.J.	--	0.478	0.812	0.563	0.276	--	0.445	2.574
N.Y.	0.061	--	0.771	0.080	0.425	0.109	0.008	1.454
Pa.	0.415	--	0.616	0.007	0.878	0.701	0.198	2.815
Maine, N.H., Vt.	--	--	0.132	0.613	0.344	0.491	0.730	2.310
Total	0.823	1.771	3.198	2.490	3.223	1.774	1.721	15.000

* Stratum 3 was empty.

sample size for major stratum 4 (for the 15 PSU allocation) was 3.198.

The allocation procedure assured that each allocation to all positive-valued cells was within one of the values shown in Table 10-18 and that the expected allocations equaled the values shown. (Note that the values shown in Table 10-18 may be added to those in Table 10-17 to obtain the Table 10-13 values.)

The 15 remaining PSUs were allocated to the stratum cells by constructing a set of allocations or allocation patterns and assigning probabilities to each pattern so that the following constraints were satisfied:

1. Allocations to each cell and to each margin differed from the Table 10-18 values by less than one in every cell and margin of every pattern.
2. Expected sample sizes for every cell and for every margin equaled the values shown in Table 10-18.

The procedure is called controlled selection because the cell, row, and column allocations were controlled for all possible patterns. The method used is a modification of one suggested by Jessen.[1]

Twenty-five patterns which satisfy the above two constraints were constructed. These patterns are shown in Appendix D. The cell, row, and column sample totals satisfy the first restriction above for each of the 25 patterns. Table 10-19 shows the probability of selection associated with each pattern. If the patterns are drawn with the stated probabilities, the probability of allocating an additional PSU to any cell will agree with the value in Table 10-18 and thus will satisfy the second restriction above. For example, the cell identified as "Major stratum 2 in Delaware, Maryland, and the District of Columbia" is allocated one PSU in patterns 1, 3, 4, 5, 7, 8, 10, 12, 13, 14, 17, 18, 19, 20, 21, 23, 24, and 25 and zero PSUs in all other patterns. The sum of the probabilities of the patterns listed above (0.177 + 0.021 + 0.081 + 0.133 + 0.008 + 0.034 + 0.018 + 0.004 + 0.027 + 0.053 + 0.011 + 0.008 + 0.004 + 0.007 + 0.004 + 0.001 + 0.001 + 0.001) is 0.593—the same value shown in Table 10-18. Similarly, it may be verified that the expected sample size for the state stratum identified as Delaware, Maryland, and the District of Columbia was 2.254: patterns 1 and 6 (probabilities 0.177 + 0.077 = 0.254) were allocated three PSUs, and the 23 other patterns were allocated two PSUs. Thus, the expected sample size for this state stratum is (3 x 0.254) + (2 x 0.746) which equals 2.254, the marginal value for Delaware, Maryland, and the District of Columbia in Table 10-18. The actual method of generating the patterns is not discussed in this monograph; but briefly, it is a numerical search for a single solution from an infinite number of possible solutions.

Within each region, a single allocation pattern was selected by drawing a random number greater than zero and less than or equal to one from a list of random digits. When the random number was compared with the accumulated probabilities shown in the last column of Table 10-19, the first pattern on the list with an accumulated probability equal to or exceeding the random number drawn was the one selected. As a hypothetical example, if the number 0.6513 were drawn, a pattern number 8 would be selected.

Selection of 208-PSU Sample

Once the sample allocation to stratum cells was completed by

Table 10-19. Probabilities Assigned to Controlled Selection Patterns

Pattern number	Pattern probability	Accumulated probability	Pattern number	Pattern probability	Accumulated probability
1	0.177	0.177	13	0.027	0.852
2	0.136	0.313	14	0.053	0.905
3	0.021	0.334	15	0.029	0.934
4	0.081	0.415	16	0.026	0.960
5	0.133	0.548	17	0.011	0.971
6	0.077	0.625	18	0.008	0.979
7	0.008	0.633	19	0.004	0.983
8	0.034	0.667	20	0.007	0.990
9	0.061	0.728	21	0.004	0.994
10	0.018	0.746	22	0.003	0.997
11	0.075	0.821	23	0.001	0.998
12	0.004	0.825	24	0.001	0.999
			25	0.001	1.000

selecting one pattern in each region, the next step was to select the assigned number of PSU's from each cell with a non-zero sample allocation. Sample PSU's within these cells were selected with probabilities proportional to estimated size (PPES sampling). Most PSU's were selected without replacement, but certain large-population PSU's were allowed a probability of being selected more than once.

The selection of PSU's in a cell with working probabilities summing to two or more was performed using a method called unequal probability sampling without replacement. Several procedures[2] are available for drawing such samples; the method used for the year 02 sample was a serial selection procedure which can be easily programmed for electronic computers and is generally applicable for any sample size as long as the normal constraints for defining the selection probabilities between zero and one are met.

The PPES sampling scheme insured that the probabilities of selecting PSU's within a stratum cell were proportional to the relative sizes of the PSU's within the cell. Departures from strictly proportional to estimated size for overall probabilities were due to the disproportionate allocation to SES strata; this factor was already reflected in the expected sample sizes assigned to each stratum cell. The probability of selection for any PSU may be expressed as:

$$P(u_{ijk}) = \sum_a P(u_{ijk} \mid n_{ij} = a)\, P(n_{ij} = a), \qquad (10.1)$$

where

$P(u_{ijk})$ = probability of selecting PSU-k of cell-ij.

$P(u_{ijk} \mid n_{ij} = a)$ = probability of selecting PSU-k of cell-ij, given an allocation a to cell-ij, and

$P(n_{ij} = a)$ = probability that a will be allocated to cell-ij.

The expected sample size for any PSU is expressed as:

$$E(n_{ijk}) = E(n_{ij}) \frac{S_{ijk}}{S_{ij}}, \qquad (10.2)$$

where

$E(n_{ij})$ = expected sample allocation to the i, j-th cell in repeated sampling of the allocation patterns,

$E(n_{ijk})$ = expected sample allocation to the k-th PSU in the i, j-th cell,

S_{ijk} = estimated size measure of the k-th PSU in i, j-th cell, and

S_{ij} = sum of the estimated size measures of all PSU's in the i, j-th cell.

(Note that $E(n_{ijk})$ is equal to $P(u_{ijk})$ when $E(n_{ijk})$ is less than or equal to one.)

In the process of selecting the sample within a cell, it was necessary to use *working probabilities* or conditional probabilities which depended upon the realized allocation to the cell as determined by probability sampling of the allocation patterns. If the selected allocation pattern assigned a specific sample size a to a cell, then the working probability (or conditional probability given a) was expressed as:

$$P(u_{ijk} \mid n_{ij} = a) = \text{Min}\left[1.0,\ a \frac{S_{ijk}}{S_{ij}}\right]. \qquad (10.3)$$

Also, the conditional expected sample size, given a, was:

$$E(n_{ijk} \mid n_{ij} = a) = a \frac{S_{ijk}}{S_{ij}}. \qquad (10.4)$$

Examples of the calculation of the overall probabilities and working probabilities for different cases are shown in Tables 10-20 through 10-23. The first example (Table 10-20) shows stratum 5531. This stratum had possible allocations of zero or one PSU under the controlled selection procedure. The probability of allocating one PSU to this stratum was 0.563 (see "New Jersey-Major stratum 5," Table 10-13). The stratum contained two PSUs. Table 10-20 shows the estimated size measures, the relative size measures, the overall probabilities of selection, working probabilities for an allocation of one PSU, and accumulated probabilities. Note that the overall probabilities of selection may be computed by using equation 10.2 with $E(n_{ij})$ equal to 0.563, and the sum of these probabilities is 0.563. Working probabilities for allocation of zero PSUs to the cell (not shown) could be considered zero in all cases, so equation 10.3 holds when a is zero. The last column in the table illustrates the mechanism for selecting the sample PSU when the allocation was one. A random number greater than zero and less than or equal to one was drawn from a random number table and compared to the accumulated working probabilities. The first PSU whose accumulated working probability entry equaled or exceeded the random number was selected for the sample; for example, if the random number were 0.4562, PSU number one would have been selected.

Table 10-21 illustrates the calculation of working probabilities when the expected sample allocation is greater than one. In this case, stratum 5439 had a minimum allocation of two PSUs (see "Pennsylvania-Major stratum 4," Table 10-17) and a probability of 0.616 of a total allocation of three (see Table 10-18). The overall PSU selection probabilities were computed using equation 10.2 with $E(n_{ij})$ equal to 2.616. The working probabilities were computed using equation 10.3 with a equal to two and three, respectively. Using equation 10.1, it can be verified that the overall probabilities achieved by this scheme agree with those shown. This can be done by noting that the

Table 10-20. Hypothetical Example of Sample Selection from Stratum 5531

Frame PSU number	1970 population	Relative size	Overall probability of selection	Working probability for allocation of 1 PSU	Accumulated working probability
1	170,492	0.4913	0.2766	0.4913	0.4913
2	176,505	0.5087	0.2864	0.5087	1.0000
Total	346,997	1.0000	0.5630	1.0000	--

Table 10-21. Hypothetical Example of Sample Selection from Stratum 5439

Frame PSU number	1970 population	Relative size	Overall probability of selection	Working probabilities	
				2 PSU's	3 PSU's
1	592,200	0.2198	0.5750	0.4396	0.6594
2	622,376	0.2310	0.6043	0.4620	0.6930
3	274,214	0.1018	0.2663	0.2036	0.3054
4	413,098	0.1533	0.4010	0.3066	0.4599
5	377,079	0.1400	0.3662	0.2800	0.4200
6	209,406	0.0777	0.2033	0.1554	0.2331
7	205,998	0.0764	0.1999	0.1528	0.2292
Total	2,694,371	1.0000	2.6160	2.0000	3.0000

probability that n_{ij} is two, denoted by $P(n_{ij} = 2)$, is 0.384 and the probability that n_{ij} is three, denoted by $P(n_{ij} = 3)$, is 0.616 and that the overall probability of selection can also be expressed as:

$$P(u_{ijk}) = P(u_{ijk} \mid n_{ij} = 2)P(n_{ij} = 2) + P(u_{ijk} \mid n_{ij} = 3)P(n_{ij} = 3) .$$

Considering the first PSU listed in Table 10-21, this becomes:

$$P(u_{ijk}) = (0.4396)(0.384) + (0.6594)(0.616) = 0.5750 .$$

This compares with the value shown in the overall probability column. Similar verification for the remaining PSUs may also be shown.

The fact that certain large population PSUs were allowed a chance of being selected more than once has been mentioned earlier. The examples which follow will illustrate situations of this kind. We have already defined the expected sample size for a PSU, equation 10.2, and the conditional expected sample size given the allocation a to the state-major-stratum cell, equation 10.4. The use for these two equations will now become apparent.

Table 10-22 illustrates the allocation of sample PSUs to the two self-representing PSU's which comprise stratum 5139 (see "Pennsylvania-Major stratum 1"). Both PSU's are self-representing since they come into the sample with probability one. Also note that the overall

Table 10-22. Hypothetical Example of Sample Selection from Stratum 5139

Frame PSU number	1970 population	Relative size	Overall expected sample size	Allocation of 3 PSUs: Conditional expected sample size	Allocation of 3 PSUs: Working probabilities	Allocation of 4 PSUs: Conditional expected sample size	Allocation of 4 PSUs: Working probabilities
1	1,927,863	0.5478	1.8707	1.6434	0.6434	2.1912	0.1912
2	1,591,270	0.4522	1.5443	1.3566	0.3566	1.8088	0.8088
Total	3,519,133	1.0000	3.4150	3.0000	1.0000	4.0000	1.0000

expected sample size for self-representing PSUs (equation 10.2) is greater than one, as shown in Table 10-22. The cell expected sample size is 3.415 (the sum of the two PSU expected sample sizes) and was shown in Table 10-13 for major stratum 1 in Pennsylvania. Thus, the cell is allocated three PSUs with probability 0.585 and four PSUs with probability 0.415. Given the cell allocation of either 3 or 4, the conditional expected sample size for each PSU is computed, as shown in Table 10-22 (equation 10.4). When a PSU conditional sample size was greater than one, the procedure used was to allocate sample PSUs to the PSUs with certainty and to subtract the certainty allocations from the conditional expected sample sizes until the remainders were all less than one. Table 10-22 shows that, if the cell allocation were three PSUs, then PSU-1 and PSU-2 would each receive one sample PSU with certainty. For a cell allocation of four PSUs, PSU-1 would receive two and PSU-2 one. In either case, the remainders are used as working probabilities to allocate the one remaining sample unit. The overall expected sample size for a PSU may be calculated as:

$$E(n_{ijk}) = \sum_{h} hP(n_{ijk} = h) . \qquad (10.5)$$

where

h = the possible allocations to PSU-ijk.

For example, in the case of PSU-1,

$$
\begin{aligned}
E(n_{ijl}) &= 1P(n_{ijl} = 1) + 2P(n_{ijl} = 2) + 3P(n_{ijl} = 3) \\
&= 1P(n_{ijl} = 1 \mid n_{ij} = 3)P(n_{ij} = 3) + 2P(n_{ijl} = 2 \mid n_{ij} = 3)P(n_{ij} = 3) \\
&\quad + 2P(n_{ijl} = 2 \mid n_{ij} = 4)P(n_{ij} = 4) + 3P(n_{ijl} = 3 \mid n_{ij} = 4)P(n_{ij} = 4) \\
&= 1(0.3566)(0.585) + 2(0.6434)(0.585) + 2(0.8088)(0.415) \\
&\quad + 3(0.1912)(0.415) \\
&= 1.8707 .
\end{aligned}
$$

The overall expected sample size for PSU-2 may be similarly verified.

Table 10-23 illustrates the use of conditional expected sample sizes for large PSUs which are not self-representing PSUs, but which have a chance of being selected more than once in the sample. It may be noted that PSU-2 of Table 10-23 has a conditional probability of .0908 of being allocated two sample PSUs. The overall expected

Table 10-23. Hypothetical Example of Sample Selection from Stratum 5221

Frame PSU number	1970 population	Relative size	Overall expected sample size	Allocation of 1 PSU: Conditional expected sample size	Allocation of 1 PSU: Working probabilities	Allocation of 2 PSUs: Conditional expected sample size	Allocation of 2 PSUs: Working probabilities
1	746,169	0.4546	0.7242	0.4546	0.4546	0.9092	0.9092
2	895,222	0.5454	0.8688	0.5454	0.5454	1.0908	0.0908
Total	1,641,391	1.0000	1.5930	1.0000	1.0000	2.0000	1.0000

sample sizes for the PSUs shown in Table 10-23 may be verified using equation 10.5 and it may be shown that equation 10.2 also gives the same values.

Selection of 52-PSU Subsample

The methods used to select and identify the total sample of 208 PSUs, 52 from each region, have now been discussed. At this point it is necessary to describe the selection of the one-fourth subsample of 52 PSUs, 13 from each region, which were used as year 02 primary sample. The one-fourth subsample of PSUs within each region could have been selected by any equal probability selection procedure. A controlled selection procedure was used to select the subsample in each region in order to maintain some control of the allocations to major strata and state strata.

Table 10-24 shows pattern 8 (appendix D) with the minimum allocations from Table 10-17 added in. Assuming pattern 8 had been selected, Table 10-24 illustrates the distribution of the 52 PSUs chosen in the Northeast region by major and state strata. The controlled selection of a subsample of 13 PSUs would have been applied using the Table 10-24 data as size measures.

Table 10-25 shows the cell and marginal expected sample allocations used to select 13 of the 52 Northeast region sample PSUs with equal probabilities. Major stratum 1' in New York had a minimum cell allocation of two PSUs; all other cells had zero minimums. Tables 10-26 and 10-27 illustrate one set of four allocation patterns which might have been used to allocate the remaining 11 subsample PSUs to state and major stratum cells. Table 10-28 shows the probabilities assigned to each of the four patterns

Table 10-24. Hypothetical Sample Allocation for the Northeast Region With Minimum Cell Allocation Added

State stratum	Major stratum* 1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	3	0	0	3
Del., Md., D.C.	0	2	2	1	0	0	0	5
Mass.	2	1	1	0	2	0	0	6
N.J.	0	1	2	1	2	0	1	7
N.Y.	11	2	0	1	2	0	1	17
Pa.	3	0	3	2	2	0	2	12
Maine, N.H., Vt.	0	0	0	0	1	1	0	2
Total	16	6	8	5	12	1	4	52

* Stratum 3 was empty.

Table 10-25. Hypothetical Expected Sample Sizes for Selecting the One-fourth Subsample in the Northeast Region

State stratum	Major stratum*							Total
	1	2	4	5	6	7	8	
Conn., R.I.	0	0	0	0	0.75	0	0	0.75
Del., Md., D.C.	0	0.50	0.50	0.25	0	0	0	1.25
Mass.	0.50	0.25	0.25	0	0.50	0	0	1.50
N.J.	0	0.25	0.50	0.25	0.50	0	0.25	1.75
N.Y.	2.75	0.50	0	0.25	0.50	0	0.25	4.25
Pa.	0.75	0	0.75	0.50	0.50	0	0.50	3.00
Maine, N.H., Vt.	0	0	0	0	0.25	0.25	0	0.50
Total	4.00	1.50	2.00	1.25	3.00	0.25	1.00	13.00

* Stratum 3 was empty.

and the accumulated probabilities used to select one of these four patterns. The number of PSUs in each cell of the selected pattern (after adding two to New York stratum 1) would be selected with equal probabilities and without replacement from the Table 10-24 PSUs of the proper state and major stratum. It may be verified that the probability of selecting any PSU in the subsample, given its selection in the 208 PSU sample (S), is equal to 0.25, or,

$$P(u'_{ijk} | S) = 0.25 \qquad (10.6)$$

For example, major stratum 6 in Connecticut and Rhode Island was allocated three PSUs in the 208 PSU sample. One is allocated to the subsample with probability 0.75. If one is allocated, each of the three initially selected have an equal probability, 1/3, of selection in the subsample. Thus,

$$P(u'_{ijk} | S) = (0.75)(\tfrac{1}{3}) = 0.25$$

Similarly, major stratum one in New York contains 11 sample PSUs. The subsample would contain two PSUs with probability 0.25 or three PSUs with probability 0.75 or:

$$P(u'_{ijk} | S) = (0.25)(\tfrac{2}{11}) + (0.75)(\tfrac{3}{11}) = 0.25$$

Table 10-26. Hypothetical Allocation Patterns 1 and 2 for Selecting the One-fourth Subsample in the Northeast Region

State stratum	Pattern 1 Major stratum number 1	2	4	5	6	7	8	Total	Pattern 2 Major stratum number 1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1
Del., Md., D.C.	0	1	0	1	0	0	0	2	0	0	1	0	0	0	0	1
Mass.	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	2
N.J.	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	2
N.Y.	1	0	0	0	1	0	0	2	0	1	0	0	0	0	1	2
Pa.	1	0	1	0	0	0	1	3	1	0	0	1	1	0	0	3
Maine, N.H., Vt.	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Total	2	1	2	1	3	1	1	11	2	2	2	1	3	0	1	11

Table 10-27. Hypothetical Allocation Patterns 3 and 4 for Selecting the One-fourth Subsample in the Northeast Region

State stratum	Pattern 3: Major stratum number 1	2	4	5	6	7	8	Total	Pattern 4: Major stratum number 1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Del., Md., D.C.	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	1
Mass.	1	0	1	0	0	0	0	2	0	0	0	0	1	0	0	1
N.J.	0	1	0	0	1	0	0	2	0	0	0	1	0	0	1	2
N.Y.	1	0	0	0	1	0	0	2	1	1	0	1	0	0	0	3
Pa.	0	0	1	1	0	0	[illegible]	3	1	0	1	0	1	0	0	3
Maine, N.H., Vt.	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Total	2	2	2	1	3	0	1	11	2	1	2	2	3	0	1	11

Thus, it is clear that the expected sample size for each PSU selected in the subsample is:

$$E(n'_{ijk}) = E(n_{ijk})P(u'_{ijk} \cdot S) = 0.25E(n_{ijk}) . \tag{10.7}$$

Selection of second stage sampling units (clusters of housing units) within each sample PSU is discussed in chapter 11.

Table 10-28. Probabilities Assigned to Controlled Selection Patterns

Pattern number	Pattern probability	Accumulated probability
1	0.25	0.25
2	0.25	0.50
3	0.25	0.75
4	0.25	1.00

WORKS CITED IN CHAPTER 10

1 R. J. Jessen. "Probability Sampling with Marginal Constraints," *Journal of the American Statistical Association*, 65 June 1970.

2 P. V. Sukhatme and B. V. Sukhatme. *Sampling Theory of Surveys With Applications*. 2nd ed. Ames, Iowa. Iowa State University Press, 1970.

CHAPTER 11

THE HOUSEHOLD SAMPLE WITHIN PSUs

Developing the Second-Stage Sampling Frame

The first step in selecting the household sample[1] within each selected PSU was to determine the total number of SSU's in the sampling frame for the PSU. Then the secondary sampling frame was constructed and the SSU's of the frame were stratified by SES.

Secondary sampling units (SSU's) were defined based on 1960 Census housing unit (HU) counts for city blocks and enumeration districts (EDs), 1960 Census numbers of families for minor civil divisions (MCDs) and census tracts (CTs), and 1970 Census preliminary population counts for counties and certain cities. The preliminary population counts were the only 1970 Census data available in late 1970 and early 1971 when the year 02 SSU's were selected.

Special tabulations showing the number of families with annual incomes less than $3,000 in 1960, by MCDs, obtained from the Census Bureau, were used along with the same type of published data for CTs to stratify the MCDs and CTs within each sample PSU.

Determining the Average SSU Size

In order to determine the total number of SSU's in the sampling frame for a PSU, it was first necessary to determine the average SSU size so that the approximate planned sample sizes shown in Table 9-3 (chapter 9) would be realized. Estimates of several sample design parameters (Table 11-1), from census data and from the year 01 household survey results, yielded an expected average of approximately 121.3 completed packages per PSU, or 12.13 per sample SSU. In order to have this expectation, the sample SSU's were defined to contain an average of 6.08 persons 26 to 35 years of age. That is,

$$\text{Young adults/SSU} = \frac{12.13}{(3.50)(.773)(.98)(.915)(.822)} = 6.08. \qquad (11.1)$$

This meant that the average sample SSU was defined to contain 16.52 occupied HU's, or 17.98 total HU's:

$$\text{Occupied HUs/SSU} = \frac{6.08}{.368} = 16.52. \quad \text{Total HUs/SSU} = \frac{6.08}{(.368)(.919)} = 17.98 \qquad (11.2)$$

Table 11-1. Expected Yield of Completed Packages for the Household Sample

Design parameters	Estimated values
Number of HU's per SSU	17.98
Proportion of HU's remaining after extra subsampling of SSU's	0.822
Number of HU's per SSU	14.78
Proportion of HU's occupied	0.919
Number of occupied HU's per SSU	13.58
Proportion of occupied HU's screened	0.915
Number of HU's screened per SSU	12.43
Number of age-eligible adults per HU	0.368
Number of age-eligible adults per SSU	4.57
Proportion eligible for NAEP	0.98
Number of eligible adults per SSU	4.48
Proportion of eligibles taking packages	0.773
Number of respondents per SSU	3.46
Number of completed packages per respondent	3.50
Number of completed packages per SSU	12.13
Number of completed packages per PSU	121.3
Total number of completed packages	6,306
Average number completed per package	1,051

Table 11-1 shows the expected yield of completed packages derived from the sample design parameter estimates. If all the sample design parameters were estimated accurately, the planned sample size of approximately 1,010 (1,051 in Table 11-1) for each young adult package (Table 9-3) would be realized.

Constructing the SSU Frame

In 1970, approximately 11.5% of the total U.S. population was 26 to 35 years of age and residing in households. This percentage was

estimated for each PSU using 1960 Census population counts by age groups and then adjusted to 1970 (see explanations in next section) before computing the number of SSU's (N) assigned to each PSU. For 1960, the expression was:

(11.3)

$$\text{Unadjusted N} = \frac{\text{estimated PSU household population aged 26-35}}{\text{desired average size of SSU}}$$

$$= \frac{\text{(1970 PSU population) (estimated proportion aged 26-35 and in households)}}{6.08}$$

(11.4)

For PSU-i in 1970,

$$\begin{array}{l}\text{Proportion aged 26-35}\\ \text{and in households}\end{array} = \left(\text{1960 PSU-i proportion aged 26-35}\right)\left(\frac{0.1150}{0.1291}\right).$$

where

0.1150 estimated proportion of U.S. population aged 26-35 residing in households in 1970, and

0.1291 estimated proportion of U.S. total population aged 26-35 in 1960.

Suppose the 1970 population of a PSU was 42,353 and that an estimated 10.8% of this population were adults from 26 to 35 years of age residing in households in 1970. Then, the number of SSUs for the PSU would be computed as:

(11.5)

$$\text{Unadjusted N} = \frac{(42{,}353)(.108)}{6.08} = 752.32 .$$

(Computation of the adjusted number, 750, is explained in the next section.)

Next, the population of each PSU was divided into "urban" and "rural" based on the preliminary 1970 Census population counts for cities with more than 2,500 population and on the county totals. Population changes from 1960 to 1970 were computed for the two areas separately and used to adjust the 1960 size measures (number of families) for MCDs and CTs within the urban and rural areas of each PSU. The adjustment made allowance for the fact that rural and urban areas may have gained or lost population at different rates from 1960 to 1970. Table 11-2 gives an example of how the adjustments were calculated for a SOC 3 PSU.

Table 11-3 shows the adjusted 1970 family counts for each MCD

Table 11-2. Urban and Rural Population Changes for a SOC 3 PSU

Area	1970 population	1960 population	Ratio of change
Urban (cities over 2,500)	30,917	25,742	1.2010
Rural (balance of PSU)	11,436	10,015	1.1419
PSU total	42,353	35,757	1.1845

and CT within the PSU. The ratios of change in Table 11-2 were applied separately to the rural and urban cumulative family columns (Table 11-3) to obtain the adjusted cumulative family values, which were rounded to the nearest integers. The "Total adjusted cumulative families" were obtained by summing the rural and urban adjusted values, and the "Cumulative SSUs" were determined by dividing each total cumulative entry by 14.75 (estimated average number of 1970 families per SSU for this PSU) and by rounding each result to the nearest integer. Thus, the first MCD listed in Table 11-3 was assigned five SSU's; the second, eight; the third, seven; and so on. The table specifies the 750 SSUs of the example PSU down to the MCD and CT levels.

Stratifying SSU's by SES

Five SES strata were formed by stratifying the SSUs within each PSU. The number of SSUs within each PSU in SOC strata 1 and 2 was determined as follows:

$$N_h = \frac{\text{unadjusted } N}{8}, \text{ for } h = 1, 2; \quad N_h = \frac{\text{unadjusted } N}{4}, \text{ for } h = 3, 4, 5, \tag{11.6}$$

where N_h is the number of SSUs in SES stratum-h. For PSUs in SOC strata 3 or 4, equal stratum sizes were determined by calculating:

$$N_h = \frac{\text{unadjusted } N}{5}, \text{ for } h = 1, 2, 3, 4, 5. \tag{11.7}$$

Each of the computed N_h values were rounded to integers and the total SSUs for the PSU was calculated as:

$$\text{Adjusted } N = \sum_{h=1}^{5} N_h. \tag{11.8}$$

Table 11-3. Second-Stage Sampling Frame Within a SOC 3 Sample PSU*

MCD or CD	Percent low-income families**	Total 1960 families	Rural families: Cumulative	Rural families: Cumulative adjusted	Urban families: Cumulative	Urban families: Cumulative adjusted	Total adjusted cumulative families	Cumulative SSU's
1	65.7	70	70	80	0	0	80	5
2	57.7	97	167	191	0	0	191	13
3	53.8	93	260	297	0	0	297	20
4	53.8	92	352	402	0	0	402	27
5	42.4	85	437	499	0	0	499	34
6	41.6	77	514	587	0	0	587	40
7	38.6	114	628	717	0	0	717	49
8	38.4	73	701	800	0	0	800	54
9	37.2	113	814	930	0	0	930	63
10	37.0	192	1,006	1,149	0	0	1,149	78
11	34.5	87	1,093	1,248	0	0	1,248	85
12	34.1	132	1,225	1,399	0	0	1,399	95
13	31.1	119	1,344	1,535	0	0	1,535	104
14	30.6	62	1,406	1,606	0	0	1,606	109
15	29.5	95	1,501	1,714	0	0	1,714	116
16	27.1	188	1,689	1,929	0	0	1,929	131
17	24.6	61	1,750	1,998	0	0	1,998	135
18	20.0	55	1,805	2,061	0	0	2,061	140
19	19.6	6,708	1,805	2,061	6,708	8,056	10,117	686
20	19.4	830	2,635	3,009	6,708	8,056	11,065	750

* Total 1960 families, 9,343; estimated 1970 families, 11,065; number of SSU's, 750; average families per SSU, 14.75.

** Earning less than $3,000 per year (1960).

For the example PSU in SOC 3,

$$N_h = 150 \approx \frac{752.32}{5}, \text{ and } N = \sum_{h=1}^{5} N_h = 750. \qquad (11.9)$$

The stratification of all SSU's by percentage of low-income families (earning less than $3,000 per year) in 1960 was specified by an ordered listing of the MCDs and CTs in Table 11-3. The first 150 SSU's listed comprise stratum one; the second 150, stratum two; and so on (Table 11-4).

Table 11-4. Identification of MCDs and CTs Containing Selected Sample SSU's of a PSU

SES stratum	Sample SSU	Frame SSU's	Random number	MCD or CT	SSU's in MCD or CT	Selected SSU
1	1	1-150	099	13	9	4
1	2	1-150	060	9	9	6
2	1	151-300	262	19	546	122
2	2	151-300	220	19	546	80
3	1	301-450	347	19	546	207
3	2	301-450	341	19	546	201
4	1	451-600	528	19	546	388
4	2	451-600	547	19	546	407
5	1	601-750	733	20	64	47
5	2	601-750	715	20	64	29

The first two substrata within each SOC 1 and 2 PSU were purposely made smaller than the other three substrata to effect the oversampling of the areas containing the highest proportion of low-income families (i.e., the low SES). The five substrata within each PSU in SOC stratum 3 or 4 were defined to be equal in size since the low SES areas had been oversampled at the PSU selection stage.

Initially, the SSU's within each MCD and CT were defined implicitly, not explicitly. Later, when a particular SSU was selected, it was necessary to define the SSU's in the MCD or CT containing the selected SSU, and further, to identify the selected SSU. One of the advantages of multistage sampling is that the sampling frame must be

developed only for the portions of the frame selected at the various stages.

Selecting the Sample SSUs

From each of the five SES substrata within each selected PSU, two SSU's were selected with equal probabilities and without replacement. Within certain large-population PSU's, which had positive probabilities of being selected in the primary sample more than once, the MCDs and CTs were stratified in the same manner as all other selected PSU's, but larger samples of SSUs were selected. Suppose a large PSU had probabilities P_1 and P_2 of being selected once and twice, respectively, in the year 02 primary sample. If the PSU was selected once, two SSU's would have been selected from each of the five SES substrata within the PSU, but if selected twice, four SSU's would have been selected from each.

Table 11-4 shows two random numbers (chosen from a random number table) for each SES stratum of the example PSU. The MCDs and CTs containing selected SSU's are identified from the frame listing (Table 11-3); thus, the fourth random number, 220, indicates that the 220th SSU (in the frame listing of 750 SSUs) was selected and that it is the 80th of the 546 SSU's located in MCD 19.

To identify the selected SSU explicitly, a listing of all 1960 Census enumeration districts (EDs) and blocks within MCD 19 was prepared from census ED microfilm and block statistics publications. The numbers of HU's for each ED and block in 1960 were listed and accumulated as shown in Table 11-5. The computed average number of 1960 HU's per SSU was used to determine the cumulative SSU's; that is, the average number (15.853 computed, or 8,656 ÷ 546) was divided into each entry of the cumulative HU's column. Each quotient was rounded to the nearest integer. In Table 11-5, the selected SSU was the 17th SSU of the 23 SSU's in ED 5 in MCD 19.

Similarly, all selected SSU's were identified down to the ED or block level. The ED or block containing the selected SSU normally contained several other SSU's which were not in the sample. Census and other mapping materials used to finally identify the sample SSU and the field procedures used to identify the households of the selected SSU are discussed in the next two sections.

Identifying the Selected SSUs

Definition of SSU's and Segments

The identified EDs and blocks containing each selected SSU usually contained several other SSU's which were not in the sample.

Table 11-5. Listing of SSUs Within MCD 19 by Block and Enumeration District

Block or ED	1960 HUs	Cumulative HUs	Cumulative SSUs	Selected SSU
1	262	262	17	--
2	240	502	32	--
3	221	723	46	--
4	278	1001	63	--
5	366	1367	86	80
6	264	1631	103	--
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
40	408	8403	530	--
41	248	8651	546	--
42	5	8656	546	--

A defined area of land containing one or more SSUs, including the selected SSU, is called a *segment*. A segment is an area within which a field interviewer conducts the assessment. Each segment has an associated sampling rate, 1/K, where K is the number of SSUs assigned to the segment. Segment identification can be considered an additional stage of sampling, but it was not in the National Assessment sample design.

When an ED contained fewer than six SSUs, including the selected SSU, the entire ED was usually designated as the segment. An ED which contained six or more SSUs was subdivided, based on the HU's counted from the HU culture shown on available county highway maps. If ED 5 (described in the previous section and in Table 11-5) is subdivided into six areas (each with identifiable boundaries), if the counts (shown in Table 11-6) were made for the six areas, and if area 4 containing seven SSUs (including the selected fourth SSU of the seven) was identified as the segment, a sketch and a county highway map showing the boundaries of area 4 and the associated sampling rate, 1/7, would be prepared for field use.

Blocks and EDs which could not be divided into areas were also designated as segments, and sketches and maps were prepared for these segments, as described above. Thus, each field supervisor received a sampling rate and a set of mapping materials from which each segment could be defined.

Table 11-6. SSU's Listed in ED 5 by Areas Defined by County Highway Maps

Area	HU's counted on maps	Cumulative HU's	Cumulative SSU's	Selected SSU
1	27	27	3	--
2	45	72	7	--
3	60	132	13	--
4	63	195	20	17
5	20	215	22	--
6	12	227	23	--

Field Cruising and Listing

The field supervisor's preliminary visit to each segment familiarized him with the area and enabled him to judge whether or not the segment contained more than 75 HU's. Segments containing 75 or fewer HU's were listed. The list, which described all HU's within the segment boundaries, was sampled systematically at the 1 K rate to identify the HU's belonging to the selected SSU.

Segments containing more than 75 HU's were divided by the field supervisor before he listed them. First, the field staff cruised the segment area in an automobile to make rough counts of the number of HU's on each street within the segment and to show them on a sketch (Figure 11-1). Next, the segment was divided into several subsegments or parts. Each subsegment was required to have recognizable boundaries. Ideally, the number of subsegments was approximately equal to the number of SSU's assigned to the segment. Then, the subsegments were numbered and listed on a sheet of paper. SSU's were assigned to subsegments, and one of the subsegments was selected.

Since the example segment (Table 11-6, Area 4) was judged to contain more than 75 HU's by the field supervisor, the segment was cruised and divided into three subsegments. Table 11-7 shows the hypothetical cruise counts for three subsegments, the assignment of seven SSU's, and the selection of subsegment 3 (by a random number from 1 to 7). A new sketch was then prepared for subsegment 3 and this area was listed.

Figures 11-2 and 11-3 are examples of a segment sketch and a completed segment list of HU's. On the sketch, single-dwelling units were indicated by Xs and multiple-dwelling units were shown as boxes containing the number of dwellings in the building. On the

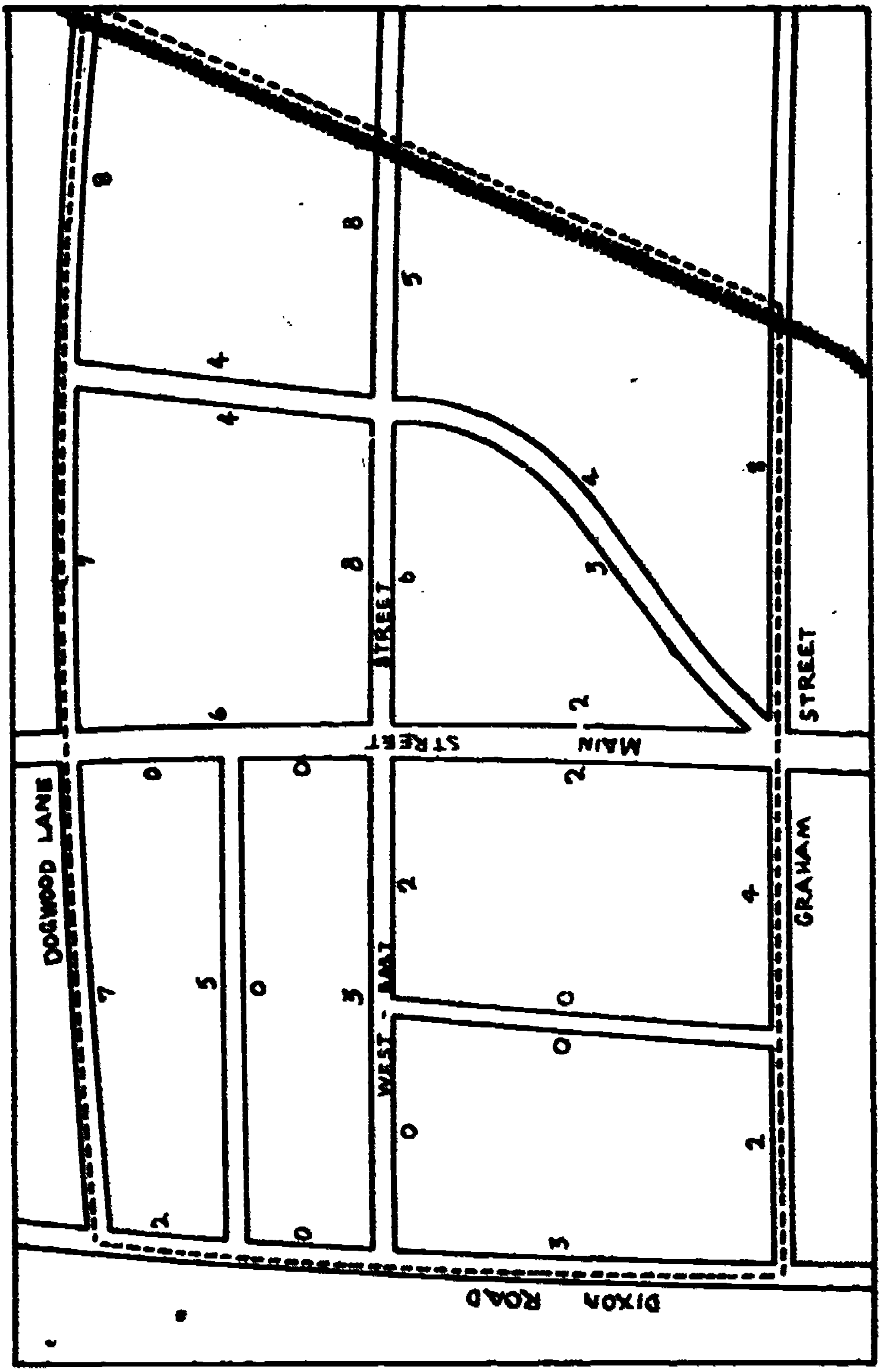

Figure 11-1. Example sketch of cruise counts.

SEGMENT SKETCH

Interviewer Phillips

Sampling Rate 1/3

PSU/Seg. No. 747011 - 31

Start No. 1

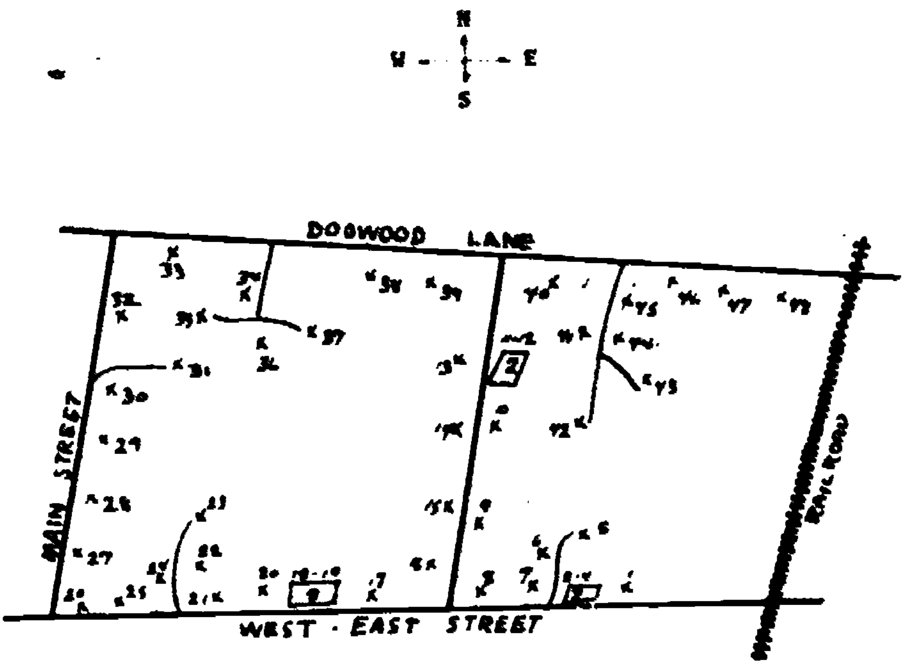

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Figure 11-2. Example of a segment sketch.

SEGMENT LIST OF HOUSING UNITS

Page 1 of 1

Sampling Rate [illegible]

Segment No. [illegible]

Start Number [illegible]

Line No.	Street Address	If Apartment, Include No. of Unit	Sample H.U. No.	Completed Material Mailed (Date)
	[illegible]			
	[illegible]	A	1	
	[illegible]	B		
	[illegible]	C		
	[illegible]		2	
	[illegible]			
	[illegible]			
	[illegible]		[illegible]	
	[illegible]			
	[illegible]			
	[illegible]	1st floor	[illegible]	
	[illegible]	2nd floor		
	[illegible]			
	[illegible]		[illegible]	
	[illegible]			
	[illegible]			
	[illegible]		[illegible]	
	[illegible]	[illegible]		
	[illegible]	left door		
	[illegible]		7	

Figure 11-3. Example of a completed list of HU's.

SEGMENT LIST OF HOUSING UNITS

Page 1 of 1

Sampling Date ________

Segment No.: [illegible]

Start Number ________

Line No.	Address or Street Address	If Apartment, Include No. or Loc.	Sample H.U. No.	Completed Material Mailed (Date)
[illegible]	[illegible]		14	
[illegible]	[illegible]			
[illegible]	[illegible]			
[illegible]	[illegible]		15	
[illegible]	[illegible]			
[illegible]	[illegible]			
[illegible]	[illegible]		16	
[illegible]	[illegible]			

Figure 11-3. (continued) Example of a completed list of HUs.

Table 11-7. Subsegments Listed in Area 4 of ED 5, Defined From Field Cruising

Subsegment	Cruise Count of HU's	Cumulative HU's	Cumulative SSU's	Random number
1	22	22	2	--
2	30	52	4	--
3	45	97	7	6

lists, the HU's were sampled systematically with a random start at the rate of 1/3 since subsegment 3 was assigned three SSU's in Table 11-7; the circled numbers indicate the HU's in the selected SSU.

Extra Subsampling

Occasionally, a selected SSU contained a very large number of HU's (e.g., a newly constructed apartment house or trailer park). It was not considered appropriate to include in the sample all the HU's contained in large-growth or "surprise" SSU's due to the cost for carrying out the assessment of a very large number and the reduction in within-SSU variance. When a selected SSU contained 40 or more HU's, extra subsampling was performed and only a part of the SSU was surveyed. Table 11-8 shows the rates used to subsample the "surprise" SSU's and the range in the number of HU's which were actually surveyed. The subsampling was effected by adjusting the

Table 11-8. Sampling Rates for Extra Subsampling of Large SSU's

Number of HU's in SSU	Proportion of SSU's surveyed	Range of HU's surveyed
0 to 39	All	0 to 39
40 to 79	1/2	20 to 40
80 to 119	1/3	26 to 40
120 to 159	1/4	30 to 40
160 to 199	1/5	32 to 40
.	.	.
.	.	.
.	.	.

rate for the listed segment (or subsegment)--that is, by multiplying the previous sampling rate for the segment (or subsegment) by the appropriate column 2 entry. Incorporation of the value for extra subsampling into the weight calculations is discussed in chapter 13.

Identifying the Sample of Eligibles

Household Screening Procedures

Field interviewers called at each of the HUs identified in column 3 of Figure 11-3 to complete the list of eligible respondents living in the HU and to administer packages to the eligibles. The Household Screening Questionnaire (Figure 11-4) and the Neighbor Questionnaire (Figure 11-5) were used to record the results of the household screening. The front of the household questionnaire was used to record the results of each call; the back was used to determine a list of persons eligible for assessment and to record the additional calls made to administer packages and the final result for each eligible.

If a competent respondent was at home for the first call, the field interviewer attempted to complete the Household Screening Questionnaire and to administer packages to all eligibles who were there. If either no one or no competent respondent was present, up to three additional calls were made to complete the questionnaire. The interviewer made the second call between 6:30 and 9:00 p.m. or on Saturday. If the HU appeared to be vacant or if no one was in the household on either the first or the second call, the interviewer contacted neighbors and completed a Neighbor Questionnaire.

Up to two calls on each of two neighbors were made to complete the Neighbor Questionnaire. If the neigbor(s) verified that the HU was vacant, no further calls were made. If the HU was not vacant, the information collected from neighbors was evaluated to decide on further actions; that is, if it appeared that there were no eligible persons in the sample household, no further calls were made; however, if the neighbor's information was incomplete and there was a possibility that a household member was eligible, additional calls were made.

A competent respondent (member of the HU judged capable to provide reliable information) of at least 17 years of age was asked for the name and birth date of each resident that was 14 years of age or older. This information was recorded in part C of the questionnaire. If the respondent seemed unsure of a birth date, it was verified with the resident. Individuals born from April 1935 to March 1945 were identified as eligible young adults and listed in the household questionnaire (Figure 11-4, part D). Questions about school enrollment in March 1970 and January 1971 were asked for HU members

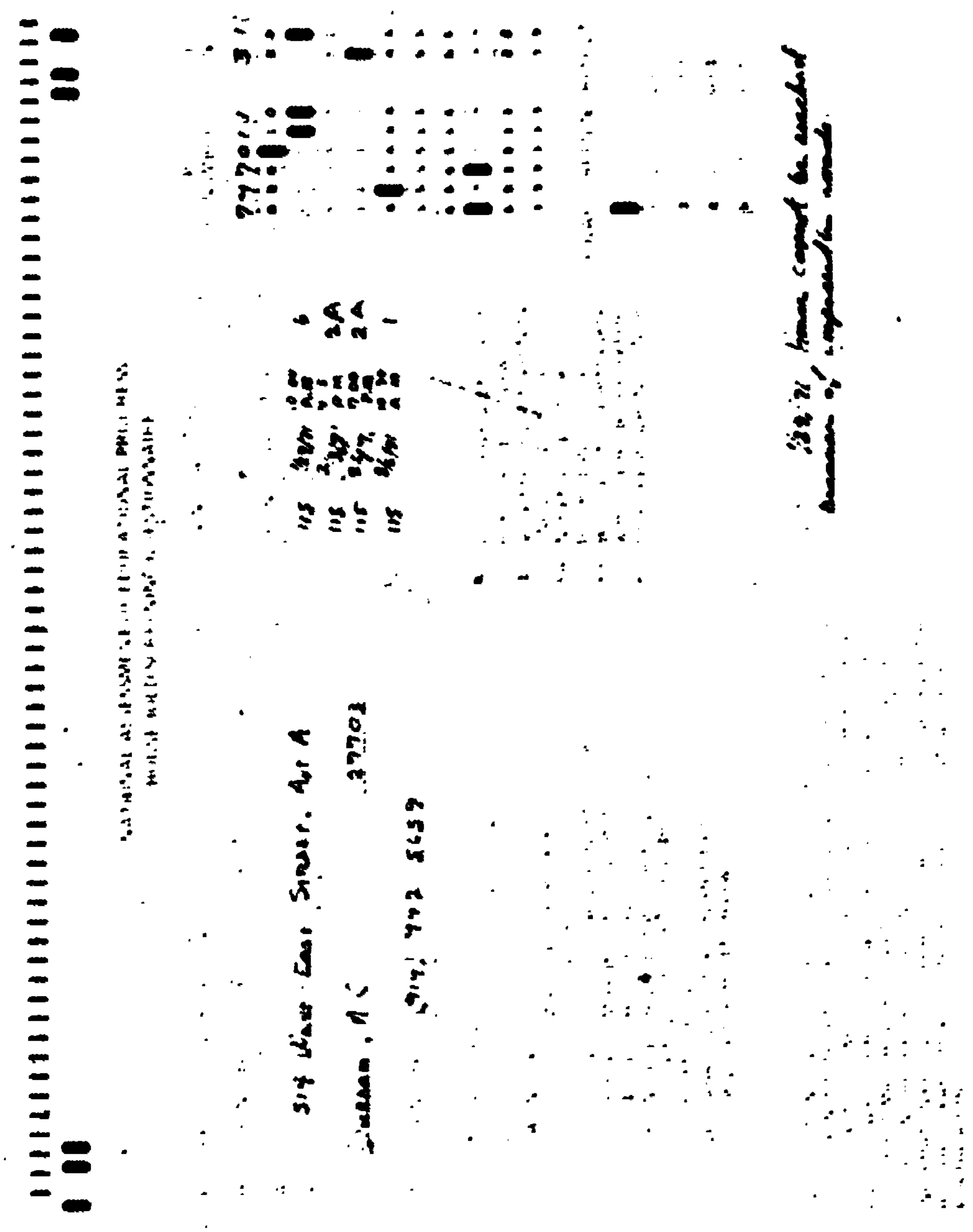

Figure 11-4. Example of Household Questionnaire.

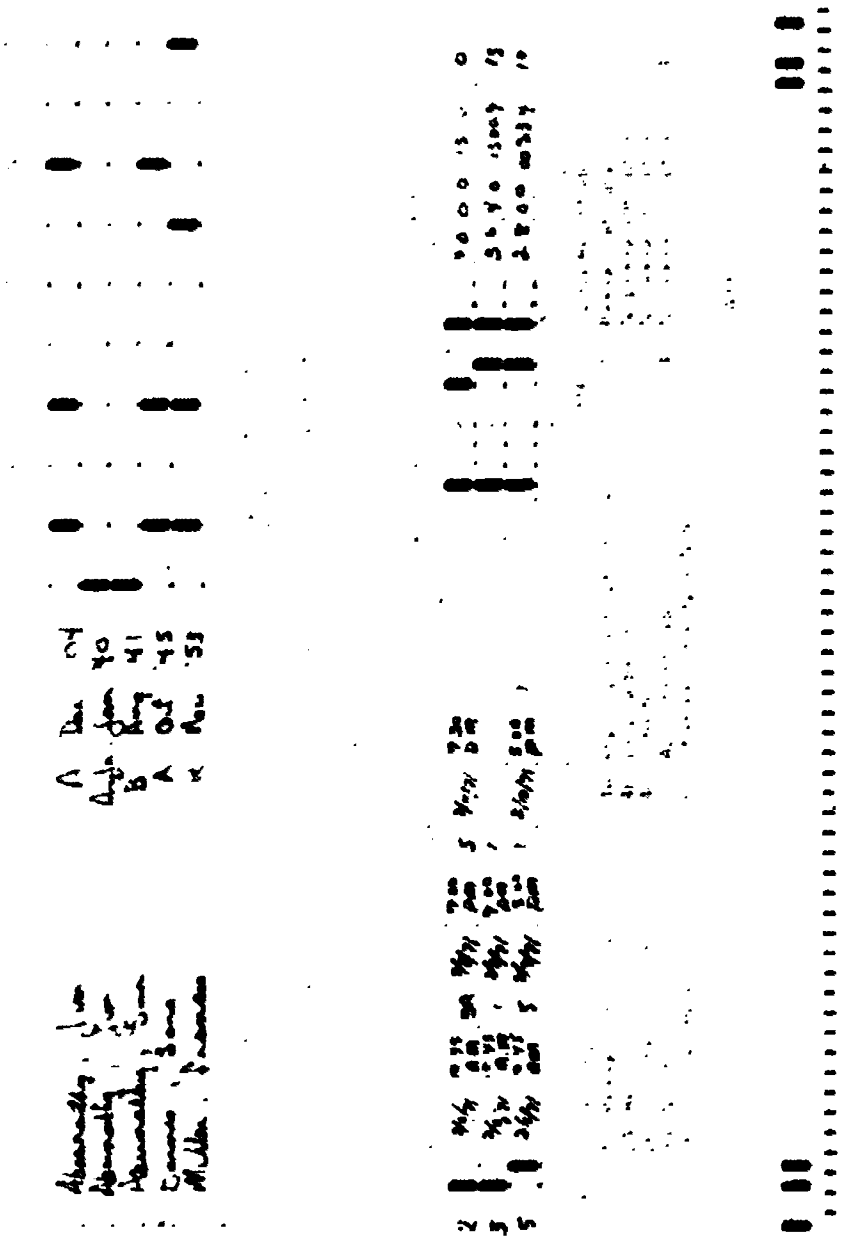

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Figure II-4. (continued) Example of Household Questionnaire

NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS

NEIGHBOR QUESTIONNAIRE

Sample
Household
Number:

Address or description of sample household:

Street Address | City

Neighbor One - Address:

Location of Neighbor One relative to location of sample household:

Neighbor Two - Address:

Location of Neighbor Two relative to location of sample household:

Call Record: Day, Date, Time, Result of Call

Neighbor One:

Neighbor Two:

Date of Interview: | Time Started:

[illegible] (CHECK IF [illegible] HOUSING UNIT IS VACANT.)

[illegible] STATEMENT

GOOD MORNING, AFTERNOON, EVENING. MY NAME IS ______. I AM WORKING FOR RESEARCH TRIANGLE INSTITUTE OF NORTH CAROLINA ON A NATIONWIDE EDUCATIONAL RESEARCH STUDY. I WANTED TO INTERVIEW A MEMBER OF THE HOUSEHOLD [illegible] BUT HAVE NOT BEEN ABLE TO GET THE INFORMATION I NEED. I WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT THE PEOPLE WHO LIVE THERE. THE INFORMATION YOU GIVE ME WILL BE CONFIDENTIAL. YOUR COOPERATION IN PROVIDING ANSWERS WILL BE APPRECIATED.

Figure 11-5. Example of Neighbor Questionnaire.

1. First, please give me the name of each person who lives there.

Last	First	M.I.	Relationship	Sex	Age

Time Interview

Figure 11-5. (continued) Example of Neighbor Questionnaire.

born from October 1952 to September 1953 and from October 1953 to September 1954, respectively, to determine eligible out-of-school 17-year-olds to be listed in the household questionnaire (part D, also).

After all eligible respondents of the HU[1] were listed in the questionnaire, up to three additional calls were made for each eligible in attempts to administer packages. Each eligible was given the option of completing one, two, three, or four packages. An incentive payment of $5 per completed package was offered to respondents agreeing to complete two or more. Respondents who were eligible by age but either physically or mentally handicapped, non-English speaking, or illiterate were not classified as eligibles. The household questionnaire is the record of the final results--the sex, race, package(s) completed, ID number, and amount of incentives paid to each age-eligible respondent.

All refusals, problems, and other cases of nonscreening or noncompletion of packages by eligible respondents were held by the field interviewer for the field supervisor, who reviewed the situation with the interviewer and suggested appropriate action.

Special Rules

Several special procedural sampling rules were applied during the survey:

1. Vacation cottages and homes which were not permanent residences were coded as "HU's occupied by persons with usual residence elsewhere." No eligibles were assessed from these.
2. Eligibles of structures or parts of structures identified by the U.S. Census definition as group quarters (hospitals, jails, dormitories, rooming or boarding houses, hotels, military barracks, or institutions) were not assessed; however, eligibles belonging to the household population but residing in structures used primarily for group quarters were included.
3. HU's missed in completing the segment list were added to the end of the list, but included in the sample only if they would normally have been listed immediately after a HU in the sample.
4. The reference date for each HU was the date the household questionnaire was completed; thus, eligibles moving into or out of the HU during the survey period were included or excluded according to the status on the date the HU was screened.

NAEP YR 02 ADULTS

INTERVIEWER 115   SERIAL NO. 1

PACKAGE ID NUMBER 15009

PACKAGE NUMBERS 3-6-4-5

Figure 11-6. Example package assignment label.

Assigning Packages to Respondents

Field interviewers attempted to administer assessment packages to all eligible young adults and out-of-school 17-year-olds in all screened, sample HU's.

There were six different packages for adults and 12 different ones for 17-year-olds. Each respondent was assigned four packages. The order of administration was indicated by a package assignment label similar to the one in Figure 11-6. The label indicates that the first adult respondent assessed by interviewer 115 was assigned packages 3, 6, 4, and 5, in that order. If the respondent agreed to complete two packages, he would take package 3 first and package 6 second. Each field interviewer had envelopes with package assignment labels attached for each of the two age groups assessed, and each envelope contained the four packages identified on the label. The interviewer used the package sets in the order indicated by the serial numbers on the labels.

The six sets of four packages, shown in Table 11-9, were assigned to adults with equal probabilities. The sets were balanced. That is, each of the six packages was included in four of the six sets and once in each of the four positions.

Table 11-9. Package Sets Assigned to Household Age Groups

Young adults		Out-of-school 17-year-olds			
Set No.	Package number	Set No.	Package number	Set No.	Package number
1	1-4-2-3	1	2-4-9-10	7	9-10-2-4
2	2-5-3-4	2	1-7-8-11	8	12-3-5-6
3	3-6-4-5	3	6-12-3-5	9	11-1-7-8
4	4-1-5-6	4	4-9-10-2	10	10-2-4-9
5	5-2-6-1	5	8-11-1-7	11	7-8-11-1
6	6-3-1-2	6	5-6-12-3	12	3-5-6-12

The 12 packages assigned to 17-year-olds were grouped into three basic sets of four packages each. Basic sets were constructed by choosing packages to minimize the duplication of exercises within each basic set. Four permutations of the package numbers of each basic set were constructed. The 12 package sets and the order of administrations are shown in Table 11-9. The 12 were balanced, that is, each package was included in four of the 12 sets and once in each

of the four positions. The 12 sets were assigned to out-of-school 17-year-olds with equal probabilities.

WORKS CITED IN CHAPTER 11

1 J. Monroe and A. L. Finkner. *Handbook of Area Sampling*. Philadelphia: Chilton Company, 1959.

CHAPTER 12

YEAR 02 HOUSEHOLD RESPONSE EXPERIENCE

General

The year 02 household survey response in terms of completed packages exceeded expectations by approximately 19% for young adults and by 74% for out-of-school 17-year-olds. The greater response was due primarily to higher household screening and package administration rates and to completion by the average respondent of more than the 3.50 packages expected. Table 12-1 summarizes the response experience for the two age groups: the average packages per respondent exceeded the 3.50 expected packages by 10.3% for young adults and by 12.0% for 17-year-olds; the expected numbers of completed packages agree with those established when the sample was selected (Table 11-1), but they are approximately 1% greater than the preliminary planned sample sizes (Table 9-3). The overall completion rate was 5.2% higher than expected for young adults and 35.2% higher than expected for out-of-school 17-year-olds.

Table 12-1. Comparison of Household Survey Response With Expected Response, by Age Groups

Sample design parameter	Young adults		Out-of-school 17-year-olds	
	Expected	Actual	Expected	Actual
Household screening rate	0.915	0.991	0.915	0.991
Package administration rate	0.773	0.751	0.773	0.965
Overall completion rate	0.707	0.744	0.707	0.956
Average packages per respondent	3.50	3.86	3.50	3.92
Total completed packages	6,306	7,743	187	325
Sample size for each package	1,051	1,246	15.6	27.1

The expected numbers of completed packages are compared to the actual survey experiences in Table 12-2. The sample contained more housing units (HUs) than expected but fewer eligible adults per HU. The loss of sample HUs from extra subsampling in very large SSUs was less than expected, based on previous experience. The

Table 12-2. Calculation of Expected Number of Completed Young Adult Packages Compared to Actual Survey Response

Sample design parameters	Presurvey estimates	Actual survey experience
Number of HU's per SSU	17.98	18.47*
Proportion of HU's remaining after extra subsampling of SSU's	0.822	0.922
Number of HU's per SSU	14.78	17.03
Proportion of HU's occupied	0.919	0.926
Number of occupied HU's per SSU	13.58	15.78
Proportion of occupied HU's screened	0.915	0.991
Number of HU's screened per SSU	12.43	15.64
Number of age-eligible adults per HU	0.368	0.327
Number of age-eligible adults per SSU	4.57	5.12
Proportion eligible for NAEP	0.98	0.969
Number of eligible adults per SSU	4.48	4.96
Proportion of eligibles taking packages	0.773	0.751
Number of respondents per SSU	3.46	3.72
Number of completed packages per respondent	3.50	3.86
Number of completed packages per SSU	12.13	14.37
Number of completed packages per PSU	121.3	143.7
Total number of completed packages	6,306	7,473

* Derived (17.03 ÷ 0.922)

proportion of HU's which were occupied and the proportion of persons 26 to 35 years of age who were eligible were approximately equal to the estimated values.

The remainder of this chapter contains more detailed year 02 household survey response data.

Field Cruising and Listing Response

Field procedures for cruising, listing, and subsegmenting were discussed briefly in chapter 11. Segments containing more than 75

HU's were cruised and subsegmented before listing; segments with 75 or fewer were listed directly, without cruising or subsegmenting. Since cruising takes less time than listing, a saving was effected by cruising the large segments, selecting a subsegment, and listing only the HU's belonging to the selected subsegment.

Table 12-3 shows that 56% of the 520 segments in the year 02 household survey were cruised and subsegmented. Of the 67,441 HU's, an average of 230 per segment was counted in cruising the 293 segments. Table 12-3 shows that 28 segments contained 40 or more HU's per SSU and that additional subsampling within these 28 segments resulted in a loss of 765 HU's (not included in the survey).

Table 12-4 shows the results of the field listing of sample HU's in the 520 segments including 227 segments listed directly and 293 subsegments listed after the segments were cruised and subsegmented. The 293 averaged 1.5 SSU's listed per subsegment, and the 227 averaged 3.2 SSU's per segment. A total of 1,159 SSU's containing 16,873 HU's (or 32 per segment, on the average) were listed in the 520 segments; 8,993 of these were sample HU's, and 157 additional sample HU's were found during the household screening, to make a total of 9,150. The 157 were HU's which were missed when the HU segment list was completed. Only those which should have been listed immediately after a sample HU were included in the sample.

Approximately 7.8% of the HU's in the 520 sample SSU's were lost due to the extra subsampling of large SSU's. The estimate was computed as 765 ÷ (765 + 8,993) = 0.078, using data from Tables 12-3 and 12-4.

Household Screening Response

The field interviewers called at each of the 9,150 sample HU's and attempted to complete household questionnaires (discussed in chapter 11). A total of 292 of the 9,150 sample HU's were businesses, vacation cottages, and other units classed as nonhousing units; thus, 8,858 HU's (or 17.03 per segment, on the average) were in the sample. There were 655 vacant HU's and 8,203 occupied HUs, or 15.78 occupied sample HU's per segment. Table 12-5 shows that screening was completed in 8,131, or in 99.1%, of the occupied sample HU's. Of the remaining occupied HUs, 28 refused to cooperate, 3 contained no competent respondent, and at 41 HUs no one was at home for four or more calls. The household screening rate of 99.1% was considerably higher than the expected rate, 91.5%. The use of the Neighbor Questionnaire information contributed to the higher screening completion rate and reduced the number of callbacks required (see chapter 11).

Table 12-3. Results of Cruising and Field Subsegmenting

Region and SOC	Area segments: Total in sample	Area segments: Total number cruised	Area segments: Percent cruised	Cruise count: Total No. of HUs	Cruise count: Avg. No. HUs per segment	Extra subsampling: No. of SSUs	Extra subsampling: No. of HUs lost
Northeast							
SOC 1	50	35	70	8,209	235	0	0
SOC 2	20	15	75	4,147	276	2	42
SOC 3	40	27	68	7,180	266	5	133
SOC 4	20	12	60	1,775	148	2	44
Total	130	89	68	21,311	239	9	219
Southeast							
SOC 1	20	8	40	3,996	500	2	45
SOC 2	10	5	50	906	181	0	0
SOC 3	40	17	42	2,971	175	0	0
SOC 4	60	32	53	6,447	201	3	83
Total	130	62	48	14,320	231	5	128
Central							
SOC 1	50	17	34	2,968	175	0	0
SOC 2	10	8	80	1,492	186	0	0
SOC 3	30	23	77	4,233	184	3	75
SOC 4	40	20	50	3,106	155	0	0
Total	130	68	52	11,799	174	3	75
West							
SOC 1	60	26	43	6,863	264	3	75
SOC 2	10	5	50	1,436	287	1	58
SOC 3	30	22	73	7,407	337	2	100
SOC 4	30	21	70	4,305	205	5	110
Total	130	74	57	20,011	270	11	343
U.S. total							
SOC 1	180	86	48	22,036	256	5	120
SOC 2	50	33	66	7,981	242	3	100
SOC 3	140	89	64	21,791	245	10	308
SOC 4	150	85	57	15,633	184	10	237
Total	520	293	56	67,441	230	28	765

Table 12-4. Results of Field Listing

Region and SOC	No. of area segments	SSUs listed: Total	SSUs listed: Average per segment	HUs listed*: Total	HUs listed*: Average per segment	Sample HUs*: Prelisted	Sample HUs*: Found by screening	Sample HUs*: Total
Northeast								
SOC 1	50	91	1.8	1,434	29	820	11	831
SOC 2	20	48	2.4	479	24	275	5	280
SOC 3	40	90	2.2	1,423	36	704	14	718
SOC 4	20	37	1.8	612	31	368	7	375
Total	130	266	2.0	3,948	30	2,167	37	2,204
Southeast								
SOC 1	20	37	1.8	616	31	326	2	328
SOC 2	10	43	4.3	295	30	85	2	87
SOC 3	40	102	2.6	1,332	33	602	0	602
SOC 4	60	120	2.0	2,016	34	1,169	26	1,195
Total	130	302	2.3	4,259	33	2,182	30	2,212
Central								
SOC 1	50	139	2.8	1,715	34	764	42	806
SOC 2	10	16	1.6	287	29	190	7	197
SOC 3	30	54	1.8	819	27	520	4	524
SOC 4	40	65	1.6	1,410	35	961	7	968
Total	130	274	2.1	4,231	33	2,435	60	2,495
West								
SOC 1	60	162	2.7	1,925	32	888	15	903
SOC 2	10	22	2.2	305	30	122	3	125
SOC 3	30	80	2.7	965	32	508	10	518
SOC 4	30	53	1.8	1,240	41	691	2	693
Total	130	317	2.4	4,435	34	2,209	30	2,239
U.S. total								
SOC 1	180	429	2.4	5,690	32	2,798	70	2,868
SOC 2	50	129	2.6	1,366	27	672	17	689
SOC 3	140	326	2.3	4,539	32	2,334	28	2,362
SOC 4	150	275	1.8	5,278	35	3,189	42	3,231
Total	520	1,159	2.2	16,873	32	8,993	157	9,150

* Includes some units which were not housing units (HUs).

Table 12-5. Results of Household Screening

Region and SOC	HUs in sample*	Vacant units	Not an HU	Occupied HUs	Results of screening calls: Not at home**	No competent respondent	Refused	Screening completed	Completion rate
Northeast									
SOC 1	831	52	35	744	3	2	8	731	0.982
SOC 2	280	6	7	267	1	0	2	264	0.989
SOC 3	718	35	24	659	1	0	3	655	0.994
SOC 4	375	19	44	312	3	0	2	307	0.984
Total	2,204	112	110	1,982	8	2	15	1,957	0.987
Southeast									
SOC 1	328	21	9	298	2	0	0	296	0.993
SOC 2	87	3	2	82	0	0	0	82	1.000
SOC 3	602	41	9	552	1	0	0	551	0.998
SOC 4	1,195	143	44	1,008	0	0	0	1,008	1.000
Total	2,212	208	64	1,940	3	0	0	1,937	0.998
Central									
SOC 1	806	40	27	739	1	0	3	735	0.995
SOC 2	197	15	1	181	0	0	0	181	1.000
SOC 3	524	39	17	468	2	0	0	466	0.996
SOC 4	968	93	10	865	3	0	2	860	0.994
Total	2,495	187	55	2,253	6	0	5	2,242	0.995
West									
SOC 1	903	51	7	845	12	1	6	826	0.978
SOC 2	125	5	1	119	9	0	1	109	0.916
SOC 3	518	39	20	459	2	0	1	456	0.993
SOC 4	693	53	35	605	1	0	0	604	0.998
Total	2,239	148	63	2,028	24	1	8	1,995	0.984
U.S. total									
SOC 1	2,868	164	78	2,626	18	3	17	2,588	0.986
SOC 2	689	29	11	649	10	0	3	636	0.980
SOC 3	2,362	154	70	2,138	6	0	4	2,128	0.995
SOC 4	3,231	308	133	2,790	7	0	4	2,779	0.996
Total	9,150	655	292	8,203	41	3	28	8,131	0.991

* Includes some units which were not HUs.

** After 4 calls

Package Administration Response

As shown in Table 12-6, a total of 2,660 adults aged 26-35 were identified in the 8,131 screened HU's, an average of 0.327 age eligibles per screened HU. A total of 83 age eligibles were classified as ineligible because they were illiterate, did not speak English, or were physically or mentally handicapped. It should be noted that the seven illiterates (nonreaders) were only those who mentioned that they could not read. No respondent was asked whether or not he could read; a number of those classified as refusals may have been nonreaders. The remaining 2,577 (96.9% of the 2,660 age eligibles) were considered eligible for the assessment. Packages were administered to 75.1% of the eligibles, 20.1% refused to take packages, and 1.8% were not at home on four or more calls at the HU.

There were 90 out-of-school 17-year-olds identified in the 8,131 screened HU's (an average of 0.011 age eligibles per HU). Eighty-three of the 86 eligibles completed packages (Table 12-7).

The average number of packages per respondent (Table 12-8) was 3.86 for adults and 3.92 for 17-year-olds, both far above the 3.50 expected. The higher averages are attributed to the incentives offered to respondents.

Package Assignment Response

The package assignment procedure (chapter 11) was designed to allocate packages to respondents with equal probabilities. The scheme had to take into account the fact that the respondents could take one, two, three, or four packages. Table 12-9 shows the number completed for each of the six adult packages and for each of the 12 out-of-school 17-year-old packages.

Table 12-6. Results of Package Administrations to Young Adults*

Region and SOC	Total No. of adults	Number of ineligibles: Physical or mental handicap	Number of ineligibles: Non-English-speaker	Number of ineligibles: Non-reader	Total No. of adults surveyed	Nonresponses: Package refused	Nonresponses: Not at home**	Total No. of respondents	Package completion rate
Northeast									
SOC 1	223	3	19	0	201	43	11	147	0.731
SOC 2	110	2	0	0	108	23	4	81	0.750
SOC 3	271	4	0	2	265	53	11	201	0.758
SOC 4	88	2	0	0	86	11	2	73	0.849
Total	692	11	19	2	660	130	28	502	0.761
Southeast									
SOC 1	86	1	0	0	85	27	3	55	0.647
SOC 2	38	0	0	0	38	3	0	35	0.921
SOC 3	198	1	0	1	196	33	7	156	0.796
SOC 4	277	6	1	0	270	54	1	215	0.796
Total	599	8	1	1	589	117	11	461	0.783
Central									
SOC 1	229	2	1	1	225	41	8	176	0.782
SOC 2	72	1	0	0	71	20	6	45	0.634
SOC 3	161	2	3	1	155	33	18	104	0.671
SOC 4	214	3	0	2	209	41	20	148	0.708
Total	676	8	4	4	660	135	52	473	0.717
West									
SOC 1	285	3	17	0	265	62	21	182	0.687
SOC 2	24	0	2	0	22	4	5	13	0.591
SOC 3	222	2	1	0	219	53	8	158	0.721
SOC 4	162	0	0	0	162	16	0	146	0.901
Total	693	5	20	0	668	135	34	499	0.747
U.S. total									
SOC 1	823	9	37	1	776	173	43	560	0.722
SOC 2	244	3	2	0	239	50	15	174	0.728
SOC 3	852	9	4	4	835	172	44	619	0.741
SOC 4	741	11	1	2	727	122	23	582	0.801
Total	2,660	32	44	7	2,577	517	125	1,935	0.751

* Aged 26 to 35.

** After 4 calls.

Table 12-7. Results of Package Administrations to Seventeen-Year Olds

Region and SOC	Total No. of 17s	Number of ineligibles: Physical or mental handicap	Non-English-speaker	Non-reader	Total No. of 17s surveyed	Nonresponses: Package refused	Not at home*	Total No. of respondents	Package completion rate
Northeast									
SOC 1	11	0	0	0	11	0	0	11	1.000
SOC 2	0	0	0	0	0	0	0	0	--
SOC 3	5	0	0	0	5	0	0	5	1.000
SOC 4	4	0	0	0	4	1	0	3	0.750
Total	20	0	0	0	20	1	0	19	0.950
Southeast									
SOC 1	7	1	0	0	6	0	0	6	1.000
SOC 2	1	0	0	0	1	0	0	1	1.000
SOC 3	7	0	0	0	7	0	0	7	1.000
SOC 4	16	1	0	0	15	0	1	14	0.933
Total	31	2	0	0	29	0	1	28	0.966
Central									
SOC 1	17	0	0	1	16	1	0	15	0.938
SOC 2	1	0	0	0	1	0	0	1	1.000
SOC 3	1	0	0	0	1	0	0	1	1.000
SOC 4	3	0	0	0	3	0	0	3	1.000
Total	22	0	0	1	21	1	0	20	0.952
West									
SOC 1	9	1	0	0	8	0	0	8	1.000
SOC 2	2	0	0	0	2	0	0	2	1.000
SOC 3	4	0	0	0	4	0	0	4	1.000
SOC 4	2	0	0	0	2	0	0	2	1.000
Total	17	1	0	0	16	0	0	16	1.000
U.S. total									
SOC 1	44	2	0	1	41	1	0	40	0.976
SOC 2	4	0	0	0	4	0	0	4	1.000
SOC 3	17	0	0	0	17	0	0	17	1.000
SOC 4	25	1	0	0	24	1	1	22	0.917
Total	90	3	0	1	86	2	1	83	0.965

* After 4 calls.

Table 12-8. Average Number of Packages Completed Per Respondent

Region and SOC	Adults 26-35 Respondents	Adults 26-35 Total packages	Adults 26-35 Average packages respondent	Out-of-school 17-year-olds Respondents	Out-of-school 17-year-olds Total packages	Out-of-school 17-year-olds Average packages respondent
Northeast						
SOC 1	147	565	3.84	11	44	4.00
SOC 2	81	303	3.74	0	0	--
SOC 3	201	767	3.82	5	20	4.00
SOC 4	73	291	3.99	3	10	3.33
Total	502	1,926	3.84	19	74	3.89
Southeast						
SOC 1	55	212	3.85	6	21	3.50
SOC 2	35	135	3.86	1	4	4.00
SOC 3	156	601	3.85	7	28	4.00
SOC 4	215	832	3.87	14	56	4.00
Total	461	1,780	3.86	28	109	3.89
Central						
SOC 1	176	685	3.89	15	60	4.00
SOC 2	45	177	3.93	1	4	4.00
SOC 3	104	407	3.91	1	4	4.00
SOC 4	148	582	3.93	3	12	4.00
Total	473	1,851	3.91	20	80	4.00
West						
SOC 1	182	692	3.80	8	30	3.75
SOC 2	13	50	3.85	2	8	4.00
SOC 3	158	616	3.90	4	16	4.00
SOC 4	146	558	3.82	2	8	4.00
Total	499	1,916	3.84	16	62	3.88
U.S. total						
SOC 1	560	2,154	3.85	40	155	3.88
SOC 2	174	665	3.82	4	16	4.00
SOC 3	619	2,391	3.86	17	68	4.00
SOC 4	582	2,263	3.89	22	86	3.91
Total	1,935	7,473	3.86	83	325	3.92

Table 12-9. Number of Packages Completed by Age Group

Package number	Number of packages completed	
	Adults	Out-of-school [illegible]-year olds
1	1,241	26
2	1,259	24
3	1,251	30
4	1,254	25
5	1,242	30
6	1,226	30
7	--	27
8	--	26
9	--	25
10	--	25
11	--	27
12	--	30
Total	7,473	325

CHAPTER 13

ESTIMATION PROCEDURES, HOUSEHOLD SAMPLE

Introduction

National Assessment estimates of the performances of populations and subpopulations on specific exercises are based on the responses of persons in the probability sample of a particular population or subpopulation.

The population parameter, P, for an exercise is defined as:

$$P = \frac{Y}{X} \tag{13.1}$$

where X, the denominator, denotes the total number of subpopulation members and Y, the numerator, denotes the number of those who would answer the exercise correctly.

In year 02, the procedure used was to estimate Y and X by $\hat{Y}$ and $\hat{X}$, respectively, and then to estimate P by $\hat{P}$:

$$\hat{P} = \frac{\hat{Y}}{\hat{X}} \tag{13.2}$$

This estimator applied to a stratified sample is called a combined ratio estimator. If other biases, such as those due to nonresponse, are ignored, unbiased estimates of Y and X can be obtained. However, the combined ratio estimate, $\hat{P}$ for P, is biased[1] due to the covariance between $\hat{P}$ and $\hat{X}$; in most relatively large samples drawn from large populations, the covariance is negligible.

Estimation at the Primary Sampling Stage

To discuss the relation of the expected sample sizes for PSUs, $E(u_{ijk})$, to the estimation procedure without discussing probabilities of selections related to later stages of the sample selection, two constants or parameters associated with each PSU, u_{ijk}, must be defined. For the P, described above, the parameter X_{ijk} is defined as the number of subpopulation members in PSU-ijk, and Y_{ijk} as the number of those who would answer the exercise correctly. The population parameters, X and Y, may be expressed in terms of X_{ijk} and Y_{ijk}:

$$X = \sum_{i}^{R} \sum_{j}^{C} \sum_{k=1}^{N_{ij}} X_{ijk} \quad \text{and} \quad Y = \sum_{i}^{R} \sum_{j}^{C} \sum_{k=1}^{N_{ij}} Y_{ijk} . \qquad (13.3)$$

where the summation is over R major strata, C state strata, and N_{ij} PSU's within each cell-ij. These expressions are valid even if N_{ij} is zero for some cells.

If the X_{ijk} and Y_{ijk} were observed for all eligible respondents in each sample PSU, unbiased estimates of X and Y could be constructed as follows:

$$\hat{X} = \sum_{i} \sum_{j} \sum_{k} \frac{n'_{ijk} X_{ijk}}{E(n'_{ijk})} \quad \text{and} \quad \hat{Y} = \sum_{i} \sum_{j} \sum_{k} \frac{n'_{ijk} Y_{ijk}}{E(n'_{ijk})} . \qquad (13.4)$$
$$(i,j,k) \in S' \qquad\qquad (i,j,k) \in S'$$

where n'_{ijk} equals the number of times u_{ijk} was selected in the 52-PSU subsample, S', and $E(n'_{ijk})$ equals the expected sample size for u_{ijk} (equation 10.7, chapter 10). Consider the expected value of $\hat{X}$, $E(\hat{X})$.

$$E(\hat{X}) = \sum_{i} \sum_{j} \sum_{k} E\left(\frac{n'_{ijk} X_{ijk}}{E(n'_{ijk})}\right)$$

$$= \sum_{i} \sum_{j} \sum_{k} \frac{1}{E(n'_{ijk})} E(n'_{ijk} X_{ijk})$$

$$= \sum_{i} \sum_{j} \sum_{k} X_{ijk} = X .$$

since the n'_{ijk} and X_{ijk} are independent, the $E(n'_{ijk})$ are fixed constants, and the summation is over the elements of the frame. Similarly $E(\hat{Y}) = Y$.

Since only a small sample of all eligible respondents in each PSU participated, it was necessary to estimate X_{ijk} and Y_{ijk} within each PSU. Details of this estimation procedure are discussed next.

Estimation of PSU Totals

For each sample PSU, estimates of X_{ijk} and Y_{ijk} were needed in order to compute:

$$\hat{p} = \frac{\hat{Y}}{\hat{X}} = \frac{\sum_{i} \sum_{j} \sum_{k} \frac{n'_{ijk} \hat{Y}_{ijk}}{E(n'_{ijk})}}{\sum_{i} \sum_{j} \sum_{k} \frac{n'_{ijk} \hat{X}_{ijk}}{E(n'_{ijk})}} \quad (i,j,k) \in S' .$$

The equations used to estimate the X_{ijk} and Y_{ijk} values were:

$$\hat{X}_{ijk} = \sum_{l=1}^{5} \frac{N_{ijkl}}{n_{ijkl}} \sum_{m} \sum_{n} \frac{X_{ijk/mn}}{P_{ijk/mn\alpha}} .$$

and (13.5)

$$\hat{Y}_{ijk} = \sum_{l=1}^{5} \frac{N_{ijkl}}{n_{ijkl}} \sum_{m} \sum_{n} \frac{Y_{ijk/mn}}{P_{ijk/mn\alpha}} .$$

where

N_{ijkl}	=	number of SSUs in secondary stratum-l of PSU-ijk;
n_{ijkl}	=	number of sample SSUs in secondary stratum-l of PSU-ijk;
$X_{ijk/mn}$	=	1 if eligible-n of SSU-m of secondary stratum-l of PSU-ijk belongs to the subpopulation, or 0 otherwise;
$Y_{ijk/mn}$	=	1 if $X_{ijk/mn}$ is 1 and the ijk/mn-th eligible correctly answered the exercise, or 0 otherwise; and
$P_{ijk/mn\alpha}$	=	the probability that the ijk/mn-th eligible is assigned package-α.

The probability, $P_{ijk/mn\alpha}$, of assigning package-α to sample eligible-ijk/mn was equal to $\frac{C_{ijk/mn}}{6}$ for young adults and $\frac{C_{ijk/mn}}{12}$ for 17-year-olds where $C_{ijk/mn}$ equals the number of packages eligible-ijk/mn completed.

Adjustments for Nonresponse

The procedures described so far assume a complete response at all stages of the sampling design. Approximately 1% of the sample housing units (HU's) were not screened and approximately 25% of the adult eligibles did not complete packages (chapter 12). Approximately 7.8% of the HU's in the sample SSUs were not surveyed due to extra subsampling of large-growth SSUs.

Nonresponse adjustments were made at the SSU level for extra subsampling by using the factor $A_{ijk/m}$, the proportion of the HUs of SSU-ijk/mn remaining after the extra subsampling. The factors $S_{ijk/m}$, the proportion of occupied housing units in SSU-ijk/m which were screened, and $R_{ijk/m}$, the proportion of eligible adults completing one or more packages in SSU-ijk/m, were used to adjust the young adult estimates (equation 13.6) for these kinds of nonresponse.

The final equations used to compute $\hat{X}_{ijk}$ and $\hat{Y}_{ijk}$ for adult exercises were:

$$\hat{X}_{ijk} = \sum_{l=1}^{\hat{s}} \frac{N_{ijk/}}{n_{ijk/}} \sum_{m} \frac{1}{A_{ijk/m}S_{ijk/m}R_{ijk/m}} \sum_{n} \frac{X_{ijk/mn}}{P_{ijk/mno}} .$$

and (13.6)

$$\hat{Y}_{ijk} = \sum_{l=1}^{\hat{s}} \frac{N_{ijk/}}{n_{ijk/}} \sum_{m} \frac{1}{A_{ijk/m}S_{ijk/m}R_{ijk/m}} \sum_{n} \frac{Y_{ijk/mn}}{P_{ijk/mno}} .$$

For the few SSU's with no responding adults, the S- and R-adjustment factors were computed from weighted sums of data for the zero-respondent SSU and a nearby SSU which had some adult respondents. For out-of-school 17-year-olds, the two factors were computed at the SOC level within each region, rather than the SSU level, since the number of respondents was very small. Other adjustments were needed for 17-year-olds since several other sampling frames were sampled and since 18-year-olds were also sampled.[2]

The estimator, $\hat{P}$, used to estimate P-values for adult exercises may also be written with weights, $W_{ijk/mno}$, as:

$$\hat{P} = \frac{\sum_i \sum_j \sum_k \sum_l \sum_m \sum_n W_{ijk/mno} \, Y_{ijk/mn}}{\sum_i \sum_j \sum_k \sum_l \sum_m \sum_n W_{ijk/mno} \, X_{ijk/mn}} \qquad (13.7)$$

where

$$W_{ijk/mno} = \frac{n'_{ijk} \, N_{ijk/}}{f(n'_{ijk} + n_{ijk/}) \, A_{ijk/m} \, S_{ijk/m} \, R_{ijk/m} \, P_{ijk/mno}} \qquad (13.8)$$

In this form, the $W_{ijk/mno}$ values are the survey weights, or expansion factors. These weights depended on the selection probabilities, the nonresponse adjustments, and the method of estimation. Equations similar to 13.7 and 13.8 may be written for the estimator and the weights used for out-of-school 17-year-olds.

WORKS CITED IN CHAPTER 13

1. M. G. Kendall and A. Stuart. *The Advanced Theory of Statistics*, Vol. III. London: Charles Griffin and Company Limited, 1966.
2. R. P. Moore and B. L. Jones. "Study of Alternative Sampling Frames for Out-of-School 17-Year-Olds," [illegible] *Technical Report No. 1*. Research Triangle Park, N.C.: Research Triangle Institute, 1971.

APPENDIXES

APPENDIX A – GLOSSARY

ACCUMULATED ALLOCATION. Cumulated sum of allocations to individual units.

ADMINISTRATION. The act of administering a National Assessment package (booklet) of exercises to one or more individuals.

ADMINISTRATIVE UNITS. Geographic areas such as states, counties, school districts, etc.

AGE ELIGIBLE. An individual who meets the age definition for one of the National Assessment populations: 9-year-olds, 13-year-olds, 17-year-olds, 26- to 35-year-olds.

AGE-K ENROLLMENT. Number of enrolled students of age-k, where k equals 9, 13, or 17 years.

AGGREGATE ESTIMATE. Estimate for a combination of smaller groups for which estimates have been produced.

ALLOCATION. Apportionment of a total sample size to various parts of the population. (See FINAL ALLOCATION.)

AREA SEGMENT. In area sampling, the total area under investigation is divided into small subareas or segments, which are then sampled.

ASSESSMENT. See NATIONAL ASSESSMENT.

ASSOCIATION RULE. In sampling, the rule specifying which observational units are to be observed in connection with the selection of a sampling unit; e.g., students attending a school are associated with that school.

AVERAGE SAMPLE SIZE. The average sample obtained per sampling unit selected.

BLOCK. Normally a well-defined piece of land, such as a city block. The U.S. Bureau of the Census published block data for all cities of 50,000 or more populations in 1970 and for other areas that have contracted for block statistics.

BLOCK GROUP (BG). (See BLOCK.) A combination of contiguous blocks with an average combined population of approximately 1,000.

CELL. The smallest unit of a table. For example, a two-way table with 5 rows and 7 columns contains 35 cells (5 x 7 = 35).

CENSUS TRACT (CT). Small, relatively permanent areas into which large cities and adjacent areas are divided for the purpose of providing small-area statistics. The average census tract contains approximately 4,000 residents.

CLUSTERING. The process of forming groups of sampling units; National Assessment clustered schools by zip code areas.

COMBINED RATIO ESTIMATOR. The ratio estimator resulting from first estimating the numerator and the denominator values and then using the quotient of these as the estimate of the ratio.

COMPLETE ENUMERATION SURVEY. Survey in which the entire population is enumerated or surveyed: a census.

COMPLETION RATE. Same as RESPONSE RATE.

CONDITION. PROBABILITY. Probability of an event, given the occurrence of another event.

CONTROLLED SELECTION. A method of probability sampling involving balanced samples on asymmetrical controls. Further controls beyond stratification are used.

CRUISING. The process of traveling all streets and roads of an area segment, making quick counts of the number of housing units on each street section.

EXPECTED VALUE. The average of the sample estimates given by an estimator over all possible samples. If the estimator is unbiased, then the expected value would result if a survey of all sampling units in the frame were conducted using the same procedures, definitions, timing, field staff, etc., used in the sample survey.

EXTRA SUBSAMPLING. Subsampling of segments which results in less than one Secondary Sampling Unit being surveyed. Used in segments with a large amount of recent growth in population, such as a newly constructed apartment house or trailer park.

FINAL ALLOCATION. Usually determined by rounding or adjusting a preliminary sample allocation to integer numbers. (See ALLOCATION.)

FIRST-STAGE SAMPLING UNIT. See MULTI-STAGE SAMPLE DESIGN.

FOURTH-STAGE SAMPLING UNIT. See MULTI-STAGE SAMPLE DESIGN.

GROUP-ADMINISTERED PACKAGE. A package containing exercises which can be administered to groups of students.

GROUP EXERCISE. An exercise, generally a multiple-choice or short-answer type, which can be administered to groups of students and does not require individual explanation.

GROUP QUARTERS. All persons who are not members of households are described as living in group quarters. This includes persons in rooming houses, military barracks, college dormitories, and institutions.

HIGH SOCIOECONOMIC STATUS (HIGH SES). Areas or schools with a relatively low incidence of poverty families or students. (See SOCIOECONOMIC STATUS.)

HOUSEHOLD. A household includes all persons who occupy a single housing unit.

HOUSEHOLD COMPLETION RATE. Proportion of sample households where the survey information was obtained.

HOUSEHOLD FRAME. Sampling frame used to select household samples, usually an area frame of census mapping materials.

HOUSEHOLD POPULATION. All persons living in housing units. (See HOUSING UNIT.)

HOUSEHOLD RESPONSE RATE. Same as HOUSEHOLD COMPLETION RATE.

HOUSEHOLD SCREENING. Process of determining the name, age, and eligibility status of each household member 14 years old or older.

HOUSEHOLD SCREENING QUESTIONNAIRE (HSQ). Form used to complete the screening of a sample household and to record response categories of eligible respondents of the household.

HOUSING UNIT (HU). Houses, apartments, groups of rooms, or single rooms intended for occupancy as separate living quarters. Specifically, a place where the occupants live and eat separately from any other persons in the structure and there is either direct access to the unit from the outside (or from a common hall) or, complete kitchen facilities for exclusive use of the occupants.

INDIVIDUAL COMPLETION RATE. Proportion of age eligibles in the sample who respond by completing one or more assessment packages.

INDIVIDUAL EXERCISE. An exercise given to one person by an administrator. May require handouts, apparatus, recording of performance, or lengthy responses.

INDIVIDUALLY ADMINISTERED PACKAGE. Package of individual exercises to be administered on an individual basis.

INELIGIBLE. Person who is not eligible for National Assessment. (See AGE ELIGIBLE.) Also includes age eligibles who are either mentally or physically handicapped so that they cannot respond to the exercises as administered, non-English-speaking, incarcerated, or nonreaders.

IN-SCHOOL SAMPLE DESIGN. Sample design for the National Assessment school survey. (See SAMPLE DESIGN.)

INSTITUTIONAL POPULATION. Persons for whom care or custody is provided in institutions. This includes inmates of mental hospitals, homes for the aged, and other institutions. (See GROUP QUARTERS.)

LISTING. Process of making a list of all observational units associated with some larger unit—for example, all housing units in an area.

LOW SOCIOECONOMIC STATUS (LOW SES). A term used to describe areas or schools with a relatively high incidence of poverty families or students.

MAJOR STRATA. Strata used to stratify the primary sampling frame within each region. Involves stratification by size of community (SOC) and by socioeconomic status (SES).

MARGINAL VALUE. A row or column total, the sum of all cell values in the row or column.

MID-RANGE AGE. Average of the minimum age and the maximum age.

MINOR CIVIL DIVISION (MCD). A tabulation area used by the Bureau of the Census. MCDs are primarily political and administrative subdivisions of counties such as towns, townships, precincts, magisterial districts, and gores.

MIXED HOUSEHOLD AND SCHOOL FRAME. Sampling frame involving use of both an area frame of households and a school frame to sample a population.

MULTI-STAGE SAMPLE DESIGN. Indicates more than one stage of sampling. An example of four-stage sampling: First stage, select a sample of counties; second stage, select a sample of blocks within each sample county; third stage, select a sample of housing units within each sample block; fourth stage, select a sample of age-eligibles within each sample housing unit. The first-stage sampling units are also called primary sampling units or PSU's.

MULTIPLE-COUNTY PSU. A primary sampling unit (PSU) composed of two or more counties.

NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS (NAEP). Also National Assessment or Assessment. A project of the Education Commission of the States (ECS). A systematic, census-like survey of the knowledge, skills, understandings, and attitudes of young Americans.

NEIGHBOR QUESTIONNAIRE. Form used to obtain information from neighbors about vacant sample housing units and those with no one at home.

9-YEAR-OLDS. One of the National Assessment target populations. For year 02, defined as persons born from January 1, 1961, through December 31, 1961.

NONRESPONSE. The failure to obtain responses or measurements for all sample elements.

NONSAMPLING ERROR. A general term applying to all sources of error except sampling error. Includes errors from defects in the sampling frame, response or measurement error, and mistakes in processing the data.

OBSERVATIONAL UNIT. The individual units for which characteristics are observed or measurements are obtained.

OUT-OF-SCHOOL SAMPLE. Area sample of out-of-school 17-year-olds and young adults of ages 26-35 residing in households.

OUT-OF-SCHOOL 17-YEAR-OLDS. For year 02, defined as (a) persons born from October 1, 1953, through September 30, 1954, who were not enrolled in elementary or secondary schools during January 1971, and (b) persons born from October 1, 1952, through September 30, 1953, who were not enrolled in elementary or secondary schools during March 1970.

OVERALL COMPLETION RATE. Estimated proportion of all sample observational units who cooperate with the survey.

OVERSAMPLING. Deliberately sampling a portion of the population at a higher rate than the remainder of the population.

P-VALUE. The estimated proportion of a target population who would answer a particular exercise correctly.

PACKAGE. An assortment of exercises designed for administration to a respondent in approximately 40-50 minutes.

PACKAGE ASSIGNMENT. The process of assigning sample packages to sampling units.

PARTICIPANT. See RESPONDENT.

POPULATION. An aggregate of elements, usually individual units with associated characteristics for observation or measurement.

POST-STRATIFICATION. Classification of selected sampling units by a set of strata definitions after the sample has been selected.

PRECISION. The difference between the expected value and the sample estimate of a population value, as measured by the sampling error.

PRIMARY SAMPLING UNIT (PSU). See MULTI-STAGE SAMPLE DESIGN.

PROBABILITY PROPORTIONAL TO ESTIMATED SIZE (PPES). Selection method where probabilities of selection for sampling units are assigned in proportion to the magnitude of the estimated size measure for each unit.

PROBABILITY SAMPLE. A sample in which every element of the population has a known, nonzero probability of being selected.

PROPORTIONAL ALLOCATION. Allocation of a sample to strata in proportion to observational units in each stratum.

PSU SIZE MEASURE. Measure of size for a primary sampling unit (PSU).

RANDOM NUMBERS. Sets of numbers used for drawing random samples. Compiled by a process involving chance and consisting of a series of digits from 0 to 9 occurring at random with equal probabilities.

RANDOM SAMPLE. See SIMPLE RANDOM SAMPLE.

RANDOM VARIABLE. A variable which takes on any value of a specified set with a particular probability.

REGION. Four regions of the country—Northeast, Southeast, Central, and West as defined by the Office of Business Economics, U.S. Department of Commerce.

RESPONDENT. A person who is eligible for National Assessment, is in the sample, and who responds by completing one or more exercise packages.

RESPONSE ERROR. The difference between the observed value and the true value for an observational unit.

RESPONSE EXPERIENCE. Response rates observed in previous surveys which are used for planning purposes.

RESPONSE RATE. Proportion of sampling units for which responses or measurements are obtained.

SAMPLE. A portion of a population, or a subset from a set of units, selected by some probability mechanism for the purpose of investigating the properties of the population.

SAMPLE DESIGN. Specifications for selecting a sample plus specifications for processing the sample data to make estimates. (See SAMPLING PLAN.)

SAMPLE DESIGN PARAMETER. A population parameter or a survey parameter, such as an expected response rate, used in designing a sample.

SAMPLE SIZE. The number of units in the sample. (Also see AVERAGE SAMPLE SIZE.)

SAMPLE SURVEY. As opposed to a census, a data collection process whereby only a sample of the population is observed or measured.

SAMPLING ERROR. The error that occurs because only a sample of the population is observed. Measured by STANDARD ERROR and VARIANCE.

SAMPLING FRAME. The list of sampling units from which the sample is selected.

SAMPLING PLAN. Set of specifications and procedures used to select a sample. (See SAMPLE DESIGN.)

SCHOOL DISTRICT. Administrative unit of the public school system, usually involving a school system under a single district organization.

SCHOOL RESPONSE RATE. The response rate for a sample of schools. (See RESPONSE RATE.)

SECONDARY SAMPLING UNIT (SSU). See MULTI-STAGE SAMPLE DESIGN.

SECOND-STAGE SAMPLING UNIT. See MULTI-STAGE SAMPLE DESIGN.

SEGMENT. See AREA SEGMENT.

SELECTION PROBABILITY. The probability, or chance, that a particular sampling unit has of being selected in the sample.

SES INDEX. A single variable, or a function of two or more variables, thought to be useful in describing the average socioeconomic status of the observational units associated with a sampling unit. (See SOCIOECONOMIC STATUS.)

SES VARIABLE. See SES INDEX.

SESSION. Same as ADMINISTRATION.

17-YEAR-OLD. One of the National Assessment target populations. For year 02, defined as persons born from October 1, 1953, through September 30, 1954.

SIMPLE RANDOM SAMPLE. Process for selecting n sampling units from a population N sampling units so that each sampling unit has an equal chance of being in the sample and every combination of n sampling units has the same chance of being in the sample chosen.

SIZE MEASURE. Value of a variable used to determine the allocation of the sample to strata or used to assign selection probabilities to sampling units within a stratum.

SIZE OF COMMUNITY (SOC). Four sizes of community strata defined at the primary sampling stage of National Assessment sampling.

SIZE STRATUM. A stratum based upon the value of the size measures for units placed in the same stratum; e.g., a stratum for the largest units.

SSU SIZE MEASURE. Measure of size for a secondary sampling unit (SSU).

STANDARD ERROR. Statistical measure or estimate of the SAMPLING ERROR.

STANDARD METROPOLITAN STATISTICAL AREA (SMSA). An area defined by the federal government for the purposes of presenting general-purpose statistics for metropolitan areas. Typically, an SMSA contains a city of at least 50,000 population plus adjacent areas.

SOCIOECONOMIC STATUS (SES). For sampling, the lower SES portion of the population (approximately 20 percent) is considered a subpopulation to be sampled.

STRATIFICATION. The division of a population into parts, called strata.

STRATIFIED SAMPLE. A sample selected from a population which has been stratified with part of the sample coming from each stratum. The strata may be either subdivisions of the population for which separate estimates are desired or subdivisions defined for the purpose of reducing sampling error.

SUBJECT AREAS. Ten academic areas identified for assessment (Art, Career and Occupational Development, Citizenship, Literature, Mathematics, Music, Reading, Science, Social Studies, and Writing).

SUBSAMPLING. Selection of a sample from a larger sample. Also used to describe multi-stage sampling.

STUDENT FRAME. List of age-eligible students within a sample school.

STUDENT LISTING FORM (SLF). Form used to construct the student frame within a sample school.

STUDENT RESPONSE RATE. The response rate for a sample of students. (See RESPONSE RATE.)

SUBSEGMENTING. Operation of subdividing the area of a segment into several subareas and selecting one of the subareas.

SUBPOPULATION. A subset of a total population, such as all male 13-year-olds in the Northeast region.

SUPPLEMENTAL PACKAGE. See SUPPLEMENTAL SAMPLE.

SUPPLEMENTAL SAMPLE. Refers to procedures used to select and assign packages to a sample of schools with very few age-eligible students.

SURVEY DESIGN. All specifications and procedures involved in a survey.

SURVEY POPULATION. The population actually surveyed or represented by the sample. May differ from the target population.

SYSTEMATIC SAMPLE (SYSTEMATIC RANDOM SAMPLE). A sample selected by a systematic method; for example, when units are selected from a list at equally spaced intervals.

TARGET POPULATION. Same as POPULATION.

THIRD-STAGE SAMPLING UNIT. See MULTI-STAGE SAMPLE DESIGN.

13-YEAR-OLD. One of the National Assessment target populations. For year 02, defined as persons born from January 1, 1957, through December 31, 1957.

UNEQUAL PROBABILITY SAMPLING. A sample selection procedure in which the sampling units have assigned selection probabilities which are not equal for all units.

VARIANCE. The square of the standard error; the average of the squared deviations of a random variable from the expected value of the variable.

WEIGHTS. The coefficients of a linear function of the sample values used to estimate population P-values. The weights depend on the selection probabilities, the nonresponse adjustments, and the estimation method.

YEAR 01, 02, 03, etc. A sequential number is assigned to each period of assessment activities in the field. Year 01 was March 1969 to February 1970. All other assessment periods (year 02, 03, etc.) start in October and are completed at the end of August. Year 02 was from October 1970 to August 1971.

YOUNG ADULT. One of the National Assessment target populations. For year 02, defined as persons born from April 1, 1935, through March 31, 1945.

APPENDIX B REQUIRED SAMPLE SIZES

Two assumptions were made to make the first sample size estimates:

1. The statistic to be estimated during year t will be the proportion, P_t, of a subpopulation that can satisfactorily complete a single exercise.
2. Sampling will be essentially random; the total universe size, N, will be large compared to the sample size, n.

The hypothesis to be tested was that of progress over time. The null hypothesis, H_0, may be stated as $P_t = P_{t+s}$ or equivalently as $P_{t+s} - P_t = 0$. For a small positive difference, d_k, an alternative hypothesis, H_k, may be stated as $P_{t+s} - P_t = d_k$. The statistical test will be one-tailed. Rejection of the null hypothesis by the data will indicate progress between times t and t+s.

The required sample size depended on several factors: the initial value of P_t, the significance level (α), the power of the test ($1-\beta$), and the specific alternative hypothesis. The significance level is the probability of making the wrong decision by rejecting the null hypothesis when it is true; the power is the probability of rejecting the null hypothesis when the alternative is true. (The probability of accepting the null hypothesis when the alternative is true is usually denoted by β, the complement of $1-\beta$.)

To determine sample size requirements for several alternatives, the following values were used: $P_t = 0.10$, 0.50, and 0.90; $d_k = 0.025$ and 0.05 for $P_t = 0.90$, $d_k = 0.05$, 0.10, 0.15, and 0.20 for $P_t = 0.10$ and 0.50; $\alpha = 0.05$ and 0.10; and $1-\beta = 0.80$, 0.90, and 0.95. The equation* used in calculating approximate sample sizes was

$$N = 1641.6 \left(\frac{K_\alpha + K_\beta}{\arcsin \sqrt{P_t} - \arcsin \sqrt{P_t + d_k}} \right)^2 \qquad \text{(B.1)}$$

where K_α and K_β are the normal deviates corresponding to the significance levels α and β. The results are shown in Table B-1. For example, to detect a difference of 0.10 with a significance level of 0.05 and power of 0.80, a sample of approximately 305 persons would be required for a P_t of 0.50.

*C. Eisenhart, M. W. Hastay, and W. A. Wallis, *Techniques of Statistical Analysis*. New York: McGraw-Hill, 1947.

Table B-1. Sample Sizes

d_k		$1-\beta$	$P_t = 0.10$	$P_t = 0.50$	$P_t = 0.90$
0.025	0.05	0.95	--	--	2,733
		0.90	--	--	2,163
		0.80	--	--	1,562
	0.10	0.95	--	--	2,163
		0.90	--	--	1,660
		0.80	--	--	1,139
0.05	0.05	0.95	940	2,158	584
		0.90	744	1,708	462
		0.80	537	1,233	334
	0.10	0.95	744	1,708	462
		0.90	571	1,311	355
		0.80	392	900	244
0.10	0.05	0.95	270	534	--
		0.90	214	423	--
		0.80	154	305	--
	0.10	0.95	214	423	--
		0.90	164	325	--
		0.80	113	223	--
0.15	0.05	0.95	133	234	--
		0.90	106	185	--
		0.80	76	134	--
	0.10	0.95	106	185	--
		0.90	81	142	--
		0.80	56	98	--
0.20	0.05	0.95	82	128	--
		0.90	65	102	--
		0.80	47	74	--
	0.10	0.95	65	102	--
		0.90	50	78	--
		0.80	34	54	--

APPENDIX C
ALLOCATION PATTERNS, WEST REGION

Appendix C. Allocation Patterns, 1-6, West Region

State strata	Pattern 1						Pattern 2						Pattern 3					
	Major stratum no.						Major stratum no.						Major stratum no.					
	2	4	5	6	7	8	2	4	5	6	7	8	2	4	5	6	7	8
Alaska	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Ariz	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Calif	0	0	0	1	0	1	1	0	0	0	0	1	1	0	0	0	0	1
Colo	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Hawaii	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Idaho	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Mont	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Nev	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
N Mex	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
Okla	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	1
Oreg	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Texas	0	0	0	0	1	1	0	1	1	0	0	0	0	0	1	0	0	1
Utah	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Wash	[illegible]	1	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0
Wyo	[illegible]	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Total	5	2	1	5	1	5	5	2	1	5	1	5	5	2	1	5	1	5

State strata	Pattern 4						Pattern 5						Pattern 6					
	Major stratum no.						Major stratum no.						Major stratum no.					
	2	4	5	6	7	8	2	4	5	6	7	8	2	4	5	6	7	8
Alaska	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Ariz	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0
Calif	0	1	0	1	0	0	0	0	0	1	0	1	0	1	0	1	0	0
Colo	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Hawaii	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Idaho	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Mont	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Nev	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
N Mex	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Okla	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1
Oreg	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Texas	1	0	0	0	0	1	[illegible]	0	0	1	0	0	1	0	0	1	0	0
Utah	1	0	0	0	0	0		0	0	0	0	0	1	0	0	0	0	0
Wash	1	0	0	1	0	0		1	0	0	0	0	1	0	0	1	0	0
Wyo	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Total	5	[illegible]	1	5	1	5	5	2	1	5	1	5	5	2	1	5	1	5

Appendix C. Allocation Patterns 7–12: West Region

State strata	Pattern 7						Pattern 8						Pattern 9					
	Major stratum no.						Major stratum no.						Major stratum no.					
	2	4	5	6	7	8	2	4	5	6	7	8	2	4	5	6	7	8
Alaska	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Ariz	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0
Calif	0	1	0	1	0	0	0	1	1	0	0	0	1	0	0	1	0	0
Colo	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0
Hawaii	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Idaho	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Mont	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Nev	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
N Mex	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Okla	1	0	1	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0
Oreg	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0
Texas	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	1	1	0
Utah	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Wash	1	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	0	1
Wyo	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Total	5	2	1	5	1	5	5	2	1	5	1	5	5	2	1	5	1	5

State strata	Pattern 10						Pattern 11						Pattern 12					
	Major stratum no.						Major stratum no.						Major stratum no.					
	2	4	5	6	7	8	2	4	5	6	7	8	2	4	5	6	7	8
Alaska	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Ariz	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Calif.	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	1	0	1
Colo	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Hawaii	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Idaho	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0
Mont	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Nev	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
N Mex	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Okla	0	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	1	0
Oreg	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Texas	0	0	0	0	1	1	1	0	0	0	1	0	1	0	0	1	0	0
Utah	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Wash	1	0	0	1	0	0	0	1	0	1	0	0	1	0	0	0	0	1
Wyo	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0
Total	5	2	1	5	1	5	5	2	1	5	1	5	5	2	1	5	1	5

Appendix C. Allocation Patterns, 13-18, West Region

State strata	Pattern 13: Major stratum no. 2	4	5	6	7	8	Pattern 14: Major stratum no. 2	4	5	6	7	8	Pattern 15: Major stratum no. 2	4	5	6	7	8
Alaska	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Ariz	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0
Calif	1	0	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0	1
Colo	1	0	[illegible]	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Hawaii	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Idaho	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Mont	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Nev	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
N Mex	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Okla	[illegible]	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	1	0
Oreg	0	[illegible]	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Texas	0	0	0	0	1	1	0	1	1	0	0	0	0	1	0	1	0	0
Utah	[illegible]	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Wash	[illegible]	0	0	1	0	0	1	0	0	0	0	1	1	0	0	[illegible]	0	1
Wyo	0	0	0	1	0	0	0	0	0	1	0	0	0	[illegible]	1	1	0	0
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	1	[illegible]	1	[illegible]	[illegible]	[illegible]	1	[illegible]	1	[illegible]

State strata	Pattern 16: Major stratum no. 2	4	5	6	7	8	Pattern 17: Major stratum no. 2	4	5	6	7	8	Pattern 18: Major stratum no. 2	4	5	6	7	8
Alaska	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Ariz	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Calif	1	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	1
Colo	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Hawaii	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Idaho	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Mont	0	0	0	1	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0
Nev	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	1
N Mex	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Okla	0	0	1	0	1	0	0	0	1	0	1	0	0	0	1	0	1	0
Oreg	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Texas	1	1	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1
Utah	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Wash	0	0	0	1	0	1	1	1	0	0	0	0	1	0	0	1	0	0
Wyo	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	1
Total	[illegible]	2	1	[illegible]	1	[illegible]	[illegible]	2	1	[illegible]	1	[illegible]	[illegible]	2	1	[illegible]	1	[illegible]

Appendix C. Allocation Patterns, 19-24, West Region

State strata	Pattern 19 Major stratum no. 2	4	5	6	7	8	Pattern 20 Major stratum no. 2	4	5	6	7	8	Pattern 21 Major stratum no. 2	4	5	6	7	8
Alaska	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Ariz	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0
Calif	0	1	1	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0
Colo	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Hawaii	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Idaho	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Mont	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Nev	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
N Mex	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Okla	1	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	1	0
Oreg	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Texas	1	1	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0
Utah	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Wash	1	0	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0
Wyo	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Total	5	2	1	5	1	5	5	2	1	5	1	5	5	2	1	5	1	5

State strata	Pattern 22 Major stratum no. 2	4	5	6	7	8	Pattern 23 Major stratum no. 2	4	5	6	7	8	Pattern 24 Major stratum no. 2	4	5	6	7	8
Alaska	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Ariz	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Calif	0	1	0	1	0	0	0	1	0	1	0	0	0	1	1	0	0	0
Colo	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0
Hawaii	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Idaho	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Mont	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Nev	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0
N Mex	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Okla	1	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	1
Oreg	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Texas	0	0	0	1	1	0	0	0	0	1	0	1	1	0	0	0	1	0
Utah	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Wash	1	1	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1
Wyo	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0
Total	5	2	1	5	1	5	5		1	5	1	5	5	2	1	5	1	5

Appendix C. Allocation Patterns, 25-30, West Region

State strata	Pattern 25 Major stratum no. 2	4	5	6	7	8	Pattern 26 Major stratum no. 2	4	5	6	7	8	Pattern 27 Major stratum no. 2	4	5	6	7	8
Alaska	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Ariz.	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Calif.	0	1	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	1
Colo.	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Hawaii	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Idaho	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Mont.	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Nev.	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
N. Mex.	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0
Okla.	1	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0	1
Oreg.	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0
Texas	1	0	0	0	1	0	0	0	0	1	0	1	1	1	0	0	0	0
Utah	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Wash.	1	0	0	0	0	1	1	1	0	0	0	0	1	0	0	1	0	0
Wyo.	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Total	5	2	1	5	1	5	5	2	1	5	1	5	5	2	1	5	1	5

State strata	Pattern 28 Major stratum no. 2	4	5	6	7	8	Pattern 29 Major stratum no. 2	4	5	6	7	8	Pattern 30 Major stratum no. 2	4	5	6	7	8
Alaska	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Ariz.	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Calif.	0	1	0	0	0	1	0	1	0	0	0	1	0	1	0	1	0	0
Colo.	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Hawaii	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Idaho	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Mont.	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Nev.	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
N. Mex.	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Okla.	0	0	1	0	0	1	0	0	1	0	0	1	1	0	0	0	1	0
Oreg.	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Texas	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	1
Utah	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Wash.	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
Wyo.	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Total	5	2	1	5	1	5	5	2	1	5	1	5	5	2	1	5	1	5

Appendix C. Allocation Patterns, 31-33, West Region

State strata	Pattern 31						Pattern 32						Pattern 33					
	Major stratum no.						Major stratum no.						Major stratum no.					
	2	4	5	6	7	8	2	4	5	6	7	8	2	4	5	6	7	8
Alaska	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Ariz.	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Calif.	0	1	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	1
Colo.	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Hawaii	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Idaho	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
Mont.	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Nev.	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
N. Mex.	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0
Okla.	1	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	1	0
Oreg.	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Texas	0	1	0	1	0	0	0	1	0	1	0	0	0	1	0	1	0	0
Utah	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
Wash.	1	0	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0	1
Wyo.	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Total	5	2	1	5	1	5	5	2	1	5	1	5	5	2	1	5	1	5

APPENDIX D
ALLOCATION PATTERNS, NORTHEAST REGION

Appendix D. Allocation Patterns, 1-6, Northeast Region

State strata	Pattern 1								Pattern 2							
	Major stratum number								Major stratum number							
	1	2	4	5	6	7	8	Total	1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Del., Md., D.C.	0	1	1	0	1	0	0	3	0	0	0	0	1	1	0	2
Mass.	0	1	0	1	1	0	0	3	0	1	1	1	1	0	0	4
N.J.	0	0	1	1	0	0	0	2	0	1	1	0	0	0	1	3
N.Y.	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1
Pa.	0	0	1	0	1	1	0	3	1	0	0	0	1	1	0	3
Me., N.H., Vt.	0	0	0	1	0	1	1	3	0	0	0	1	0	0	1	2
Total	0	2	4	3	3	2	1	15	1	2	3	2	3	2	2	15

State strata	Pattern 3								Pattern 4							
	Major stratum number								Major stratum number							
	1	2	4	5	6	7	8	Total	1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Del., Md., D.C.	0	1	0	1	0	0	0	2	0	1	0	1	0	0	0	2
Mass.	1	0	1	1	1	0	0	4	1	0	1	1	1	0	0	4
N.J.	0	0	1	1	0	0	0	2	0	1	1	1	0	0	0	3
N.Y.	0	0	1	0	1	0	0	2	0	0	1	0	1	0	0	2
Pa.	0	0	1	0	1	1	0	3	0	0	0	0	1	1	0	2
Me., N.H., Vt.	0	0	0	0	1	0	1	2	0	0	0	0	1	0	1	2
Total	1	1	4	3	4	1	1	15	1	2	3	3	4	1	1	15

State strata	Pattern 5								Pattern 6							
	Major stratum number								Major stratum number							
	1	2	4	5	6	7	8	Total	1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Del., Md., D.C.	0	1	0	0	0	1	0	2	0	0	0	1	0	1	1	3
Mass.	0	1	0	1	1	0	0	3	1	1	1	0	1	0	0	4
N.J.	0	0	1	0	0	0	1	2	0	1	0	1	1	0	0	3
N.Y.	0	0	1	0	1	0	0	2	0	0	1	0	0	0	0	1
Pa.	1	0	1	0	1	0	0	3	0	0	0	0	1	1	0	2
Me., N.H., Vt.	0	0	0	1	0	1	1	4	0	0	1	0	0	0	1	2
Total	1	2	3	2	3	2	2	15	1	2	3	2	3	2	2	15

Appendix D. Allocation Patterns, 7-12, Northeast Region

State strata	Pattern 7								Pattern 8							
	Major stratum number								Major stratum number							
	1	2	4	5	6	7	8	Total	1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Del., Md., D.C.	0	1	0	1	0	0	0	2	0	1	0	1	0	0	0	2
Mass.	1	1	1	0	1	0	0	4	1	1	1	0	1	0	0	4
N.J.	0	0	1	1	1	0	0	3	0	0	1	1	0	0	1	3
N.Y.	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1
Pa.	0	0	1	0	1	0	1	3	0	0	1	0	1	0	1	3
Me., N.H., Vt.	0	0	0	0	1	1	0	2	0	0	0	0	1	1	0	2
Total	1	2	3	2	4	1	2	15	1	2	3	2	4	1	2	15

State strata	Pattern 9								Pattern 10							
	Major stratum number								Major stratum number							
	1	2	4	5	6	7	8	Total	1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Del., Md., D.C.	0	0	0	0	0	1	1	2	0	1	0	1	0	0	0	2
Mass.	0	1	1	0	1	0	0	3	0	0	1	0	1	0	1	3
N.J.	0	1	1	0	1	0	0	3	0	0	1	1	1	0	0	3
N.Y.	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	2
Pa.	0	0	1	0	1	0	1	3	1	0	1	0	0	1	0	3
Me., N.H., Vt.	0	0	0	1	1	0	0	2	0	0	0	0	1	0	1	2
Total	1	1	3	3	4	1	2	15	1	1	3	2	4	2	2	15

State strata	Pattern 11								Pattern 12							
	Major stratum number								Major stratum number							
	1	2	4	5	6	7	8	Total	1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Del., Md., D.C.	0	0	0	1	0	0	1	2	0	1	1	0	0	0	0	2
Mass.	0	1	1	0	1	0	0	3	1	0	0	1	0	0	1	3
N.J.	0	1	1	1	0	0	0	3	0	0	0	1	1	0	1	3
N.Y.	0	0	1	0	0	1	0	2	0	0	1	0	1	0	0	2
Pa.	1	0	0	0	1	1	0	3	0	0	1	0	1	1	0	3
Me., N.H., Vt.	0	0	0	0	1	0	1	2	0	0	0	1	0	1	0	2
Total	1	2	3	2	3	2	2	15	1	1	3	3	3	2	2	15

Appendix D. Allocation Patterns, 13-18, Northeast Region

State strata	Pattern 13: Major stratum number 1	2	4	5	6	7	8	Total	Pattern 14: Major stratum number 1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1
Del., Md., D.C.	0	1	1	0	0	0	0	2	0	1	1	0	0	0	0	2
Mass.	1	0	0	1	0	0	1	3	1	0	1	1	0	0	0	3
N.J.	0	0	1	0	1	0	1	3	0	0	0	1	1	0	1	3
N.Y.	0	0	0	1	1	0	0	2	0	0	0	0	1	0	0	1
Pa.	0	0	1	0	0	1	0	2	0	0	1	0	0	1	1	3
Me., N.H., Vt.	0	0	0	1	0	1	0	2	0	0	0	1	0	1	0	2
Total	1	1	3	3	3	2	2	15	1	1	3	3	3	2	2	15

State strata	Pattern 15: Major stratum number 1	2	4	5	6	7	8	Total	Pattern 16: Major stratum number 1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1
Del., Md., D.C.	0	0	0	1	0	1	0	2	0	0	0	1	0	1	0	2
Mass.	0	1	0	0	1	0	1	3	1	1	0	0	0	0	1	3
N.J.	0	1	0	0	0	0	1	2	0	0	1	0	1	0	0	2
N.Y.	0	0	1	0	1	0	0	2	0	0	1	1	0	0	0	2
Pa.	1	0	1	0	1	0	0	3	0	0	1	0	1	0	1	3
Me., N.H., Vt.	0	0	1	0	0	1	0	2	0	0	0	0	1	1	0	2
Total	1	2	3	2	3	2	2	15	1	1	3	3	3	2	2	15

State strata	Pattern 17: Major stratum number 1	2	4	5	6	7	8	Total	Pattern 18: Major stratum number 1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1
Del., Md., D.C.	0	1	0	0	0	1	0	2	0	1	1	0	0	0	0	2
Mass.	0	0	1	0	1	0	1	3	1	0	0	1	1	0	0	3
N.J.	0	0	0	1	0	0	1	2	0	0	1	0	0	0	1	2
N.Y.	0	0	0	1	1	0	0	2	0	0	0	1	0	1	0	2
Pa.	1	0	1	0	0	1	0	3	0	0	0	0	1	1	1	3
Me., N.H., Vt.	0	0	1	1	0	0	0	2	0	0	1	0	1	0	0	2
Total	1	1	3	3	3	2	2	15	1	1	3	3	3	2	2	15

Appendix D. Allocation Patterns, 19-24, Northeast Region

State strata	Pattern 19								Pattern 20							
	Major stratum number								Major stratum number							
	1	2	4	5	6	7	8	Total	1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1
Del., Md., D.C.	0	1	0	1	0	0	0	2	0	1	1	0	0	0	0	2
Mass.	0	0	1	1	0	0	1	3	0	0	1	1	1	0	0	3
N.J.	0	1	0	1	0	0	0	2	0	1	0	0	0	0	1	2
N.Y.	0	0	1	0	1	0	0	2	0	0	0	1	1	0	0	2
Pa.	1	0	1	0	0	1	0	3	1	0	1	0	0	1	0	3
Me., N.H., Vt.	0	0	0	0	1	0	1	2	0	0	0	1	0	0	1	2
Total	1	2	3	3	3	1	2	15	1	2	3	3	3	1	2	15

State strata	Pattern 21								Pattern 22							
	Major stratum number								Major stratum number							
	1	2	4	5	6	7	8	Total	1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1
Del., Md., D.C.	0	1	0	1	0	0	0	2	0	0	1	1	0	0	0	2
Mass.	1	0	0	0	1	0	1	3	1	1	0	0	0	0	1	3
N.J.	0	1	1	0	0	0	0	2	0	1	1	0	0	0	0	2
N.Y.	0	0	1	0	0	1	0	2	0	0	1	0	0	1	0	2
Pa.	0	0	0	1	1	0	1	3	0	0	0	1	1	0	1	3
Me., N.H., Vt.	0	0	1	0	1	0	0	2	0	0	0	1	1	0	0	2
Total	1	2	3	3	3	1	2	15	1	2	3	3	3	1	2	15

State strata	Pattern 23								Pattern 24							
	Major stratum number								Major stratum number							
	1	2	4	5	6	7	8	Total	1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1
Del., Md., D.C.	0	1	0	1	0	0	0	2	0	1	0	1	0	0	0	2
Mass.	0	1	1	1	0	0	0	3	0	0	1	1	0	0	1	3
N.J.	0	0	0	0	1	0	1	2	0	1	0	0	0	0	1	2
N.Y.	0	0	0	1	1	0	0	2	0	0	0	0	1	1	0	2
Pa.	1	0	1	0	0	1	0	3	1	0	1	0	1	0	0	3
Me., N.H., Vt.	0	0	1	0	0	0	1	2	0	0	1	0	1	0	0	2
Total	1	2	3	3	3	1	2	15	1	2	3	3	3	1	2	15

Appendix D. Allocation-Pattern 25, Northeast Region

State strata	Pattern 25							
	Major stratum number							
	1	2	4	5	6	7	8	Total
Conn., R.I.	0	0	0	0	1	0	0	1
Del., Md., D.C.	0	1	0	1	0	0	0	2
Mass.	1	1	0	1	0	0	0	3
N.J.	0	0	0	0	1	0	1	2
N.Y.	0	0	1	0	1	0	0	2
Pa.	0	0	1	0	0	1	1	3
Me., N.H., Vt	0	0	1	1	0	0	0	2
Total	1	2	3	3	3	1		15

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